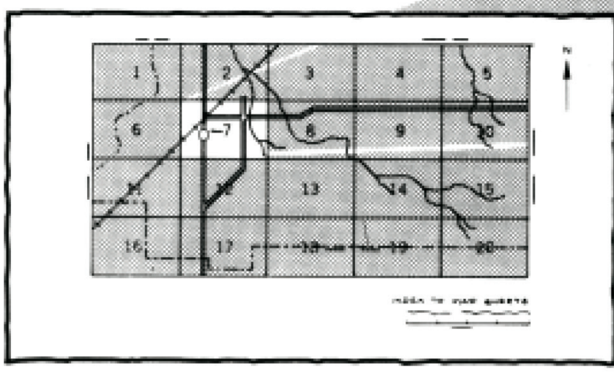
SOIL SURVEY OF

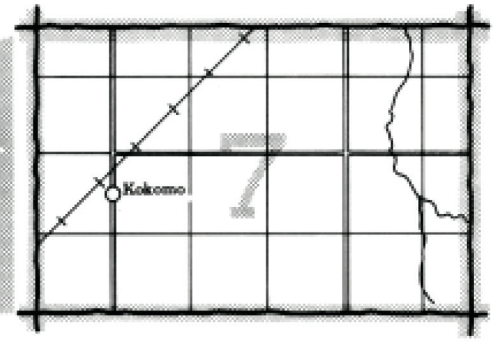
Marshall County, Kansas

United States Department of Agriculture,
Soil Conservation Service,
in cooperation with
the Kansas Agricultural Experiment Station

HOW TO USE

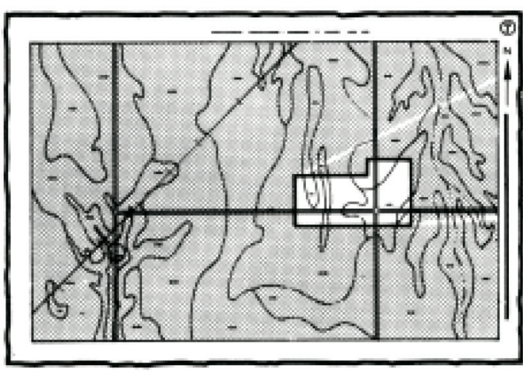
1. Locate your area of interest on the "Index to Map Sheets"

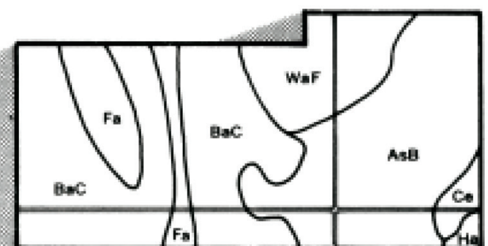




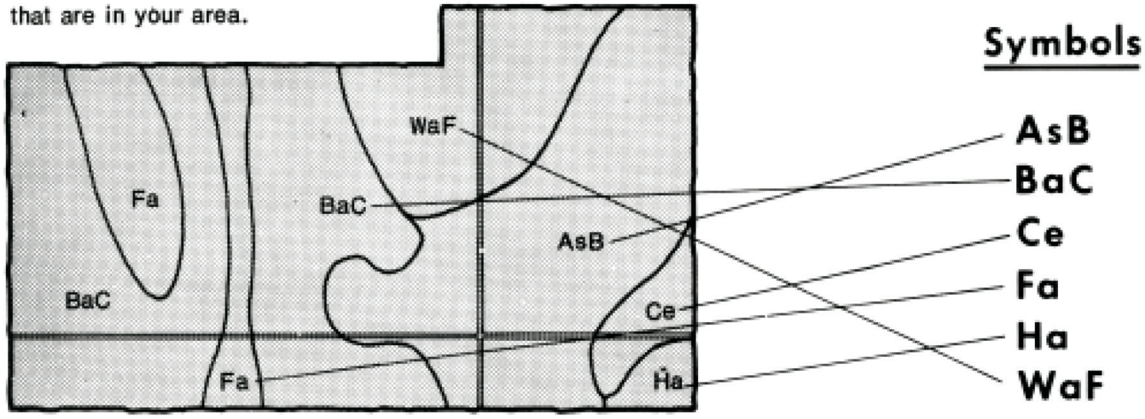
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



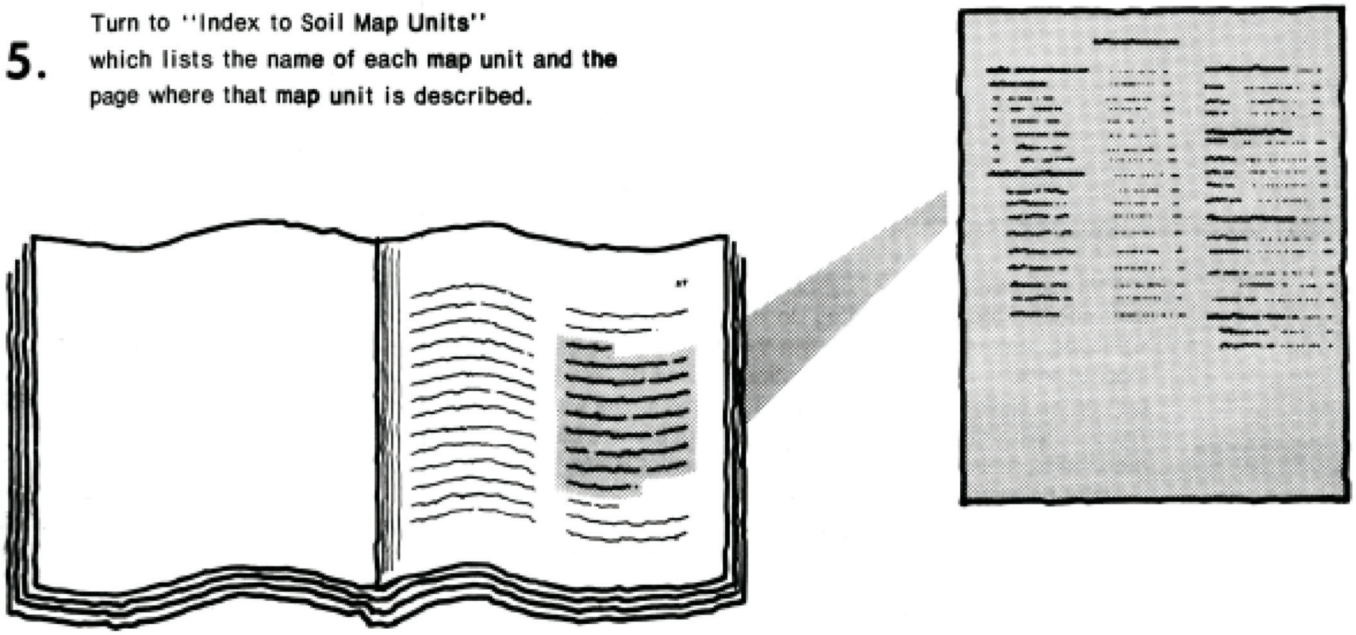


4. List the map unit symbols that are in your area.

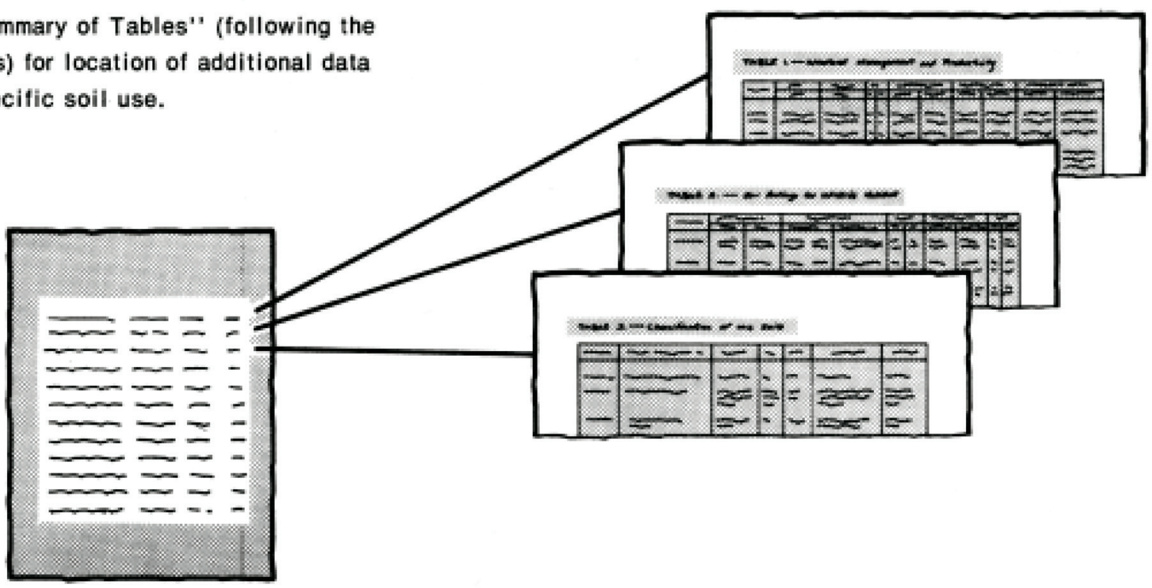


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was performed in the period 1966-1976. Soil names and descriptions were approved in 1977. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1976. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Marshall County Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Corn on Kennebec silt loam and Muir silt loam on bottom land of a creek.

Contents

Issued September 1980

Index to map units

Summary of tables

Summary of tables—Continued

Foreword

This soil survey contains information that can be used in land-planning programs in Marshall County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

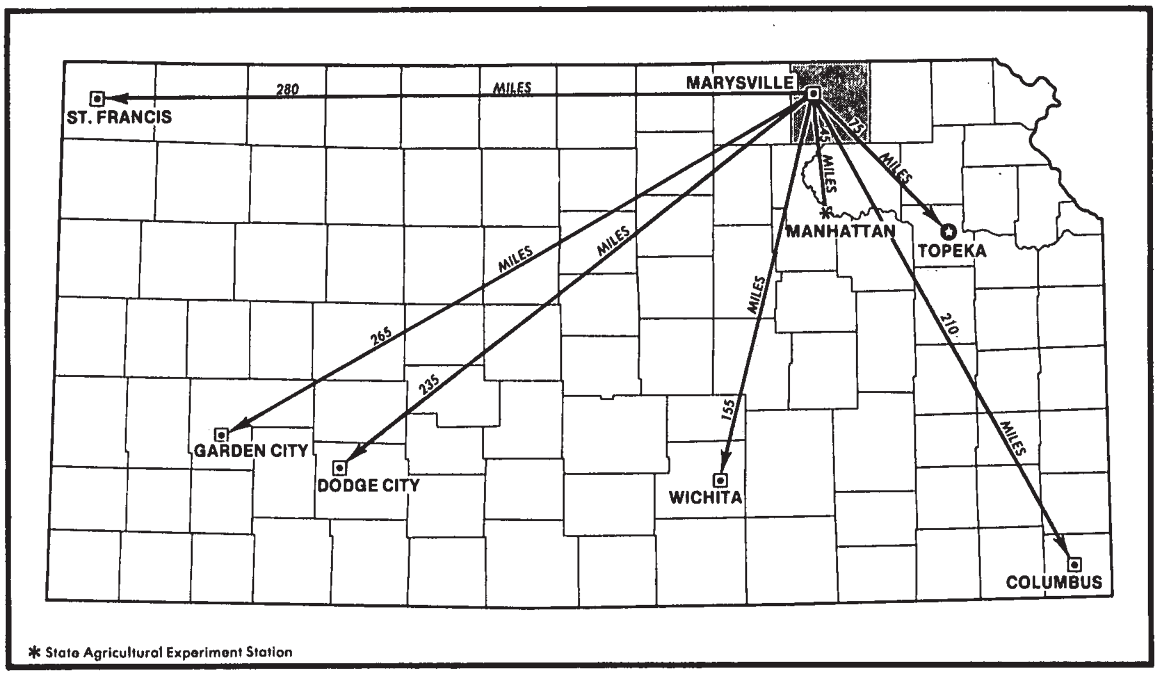
This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

John W. Tippie

John W. Tippie
State Conservationist
Soil Conservation Service



Location of Marshall County in Kansas.

SOIL SURVEY OF MARSHALL COUNTY, KANSAS

By Paul R. Kutnink, Donald A. Gier, Roger L. Haberman, Donald R. Jantz

United States Department of Agriculture, Soil Conservation Service, in cooperation with the Kansas Agricultural Experiment Station

Marshall County is on the northern boundary of Kansas adjacent to Nebraska. The county has a total area of 911 square miles or 583,040 acres. In 1976 the population was 13,936, and in Marysville, the county seat, the population was 3,890.

Marshall County was organized in 1855. The western two-thirds of Marshall County is in the Bluestem Hills land resource area and most of the rest is in the Nebraska-Kansas Loess-Drift Hills land resource area. The Bluestem Hills have deeply entrenched drainageways. The soils are generally deep, gently sloping to steep with a clayey subsoil. The Nebraska-Kansas Loess-Drift Hills generally have deep, nearly level to moderately sloping soils with a clayey subsoil. Elevation ranges from 1,090 to 1,530 feet above sea level.

Most of Marshall County is drained by three permanent flowing streams: Big Blue, Little Blue, and Black Vermillion Rivers. These streams flow in a southerly direction.

Marshall County has a continental climate. Summers are hot, and winters are cold. Mean annual temperature is 40 to 65 degrees F. Annual precipitation ranges from 25 to 35 inches.

The main enterprises in the county are farming and ranching. Wheat and sorghum are the main crops.

General nature of the county

This section gives general information concerning the county. It discusses climate and natural resources.

Climate

By L. Dean Bark, climatologist, Kansas Agricultural Experiment Station.

The climate of Marshall County is the typical continental type expected in the interior of a large land mass in the middle latitudes. It is characterized by large daily and annual variations in temperature. Winters are cold because of the frequent outbreaks of air from the Polar regions. Winter conditions prevail from December to February. Warm temperatures of summer last for about 6 months every year, and the transition seasons of spring and fall are relatively short. The warm temperatures provide a long growing season for crops in the county.

Marshall County frequently receives currents of moisture-laden air from the Gulf of Mexico. Precipitation is heaviest late in spring and early in summer. Most of it comes as thunderstorms late in evening or at night. Although the total precipitation is generally adequate for any crop, its distribution may cause problems in some years. Prolonged dry periods of several weeks duration are not uncommon during the growing season. A surplus of precipitation often produces muddy fields that delay planting and harvest operations.

Tornadoes and severe thunderstorms occur occasionally in Marshall County; they are usually local and of short duration so that risk is small. Hail occurs during the warmer part of the year, but it is infrequent and of local nature. Crop damage by hail is less in this part of the state than it is in western Kansas.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Marysville in the period 1949 to 1970. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 28.0 degrees F, and the average daily minimum temperature is 16.7 degrees. The lowest temperature on record, which occurred at Frankfort on February 13, 1905, is -35 degrees. In summer the average temperature is 76.2 degrees, and the average daily maximum temperature is 88.5 degrees. The highest recorded temperature, which occured on June 25, 1911, is 114 degrees.

The total annual precipitation is 31.29 inches. Of this, 23.71 inches, or 76 percent usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 20.34 inches. The heaviest 1-day

rainfall during the period of record was 6.10 inches at Marysville on July 24, 1972.

Average seasonal snowfall is 19.6 inches. On an average of 25 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

The sun shines 75 percent of the time possible in summer and 60 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 13 miles per hour, in March and April.

Natural resources

Soil is the most important natural resource in the county. Livestock that graze the rangeland and crops produced are marketable products that are affected by the soil.

Other resources of Marshall County are sand and gravel. Sand and gravel are available from deposits in the glacial till.

How this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, rangeland and woodland managers, engineers, planners, developers and builders, home buyers, and others.

General soil map for broad land use planning

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The names and descriptions of the soils identified on the general soil map for this county do not fully agree with those of the soils identified on the maps for adjacent counties. Differences result from a better knowledge of the soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the counties.

1. Muir-Eudora-Nodaway

Deep, nearly level, well drained and moderately well drained soils on flood plains and terraces

This map unit makes up about 6 percent of the county. It is about 32 percent Muir soils, 24 percent Eudora soils, 17 percent Nodaway soils, and 27 percent minor soils.

The Muir soils are well drained. They formed in silty alluvium on low terraces that are rarely flooded. The surface layer typically is very dark brown and very dark grayish brown silt loam about 29 inches thick. The subsoil is dark brown, friable silt loam about 16 inches thick. The substratum, to a depth of about 60 inches, is dark grayish brown silt loam.

The Eudora soils are well drained. They formed in silty alluvium on bottom lands that are rarely or occasionally

flooded. The surface layer typically is very dark brown and very dark grayish brown silt loam about 14 inches thick. The substratum, to a depth of about 60 inches, is dark grayish brown silt loam.

The Nodaway soils are moderately well drained. They formed in silty alluvium on bottom lands that are frequently flooded. The surface layer typically is very dark grayish brown silt loam about 8 inches thick. The substratum, to a depth of about 60 inches, is stratified, very dark grayish brown silt loam.

The minor soils in this map unit are the frequently flooded, moderately well drained Kennebec soils along the creeks; the well drained Tully soils on foot slopes; and the very poorly drained Wabash soils in low areas.

The soils in this map unit are mainly used for cultivated crops, but some small areas are used for hay and pasture. Corn, grain sorghum, wheat, and soybeans are the main crops. Flooding is a hazard. Maintaining tilth and fertility are concerns in management.

These soils have good potential for cultivated crops, range, and woodland and for openland and woodland wildlife habitat. They have fair to poor potential for most engineering uses because of flooding.

2. Wabash-Nodaway-Muir

Deep, nearly level, very poorly drained, moderately well drained, and well drained soils on flood plains and terraces

This map unit makes up about 4 percent of the county. It is about 49 percent Wabash soils, 17 percent Nodaway soils, 12 percent Muir soils, and 22 percent minor soils.

The Wabash soils are very poorly drained. They formed in clayey alluvium on frequently flooded bottom lands. The surface layer typically is black silty clay loam about 13 inches thick. The subsoil, to a depth of about 60 inches, is black, very firm silty clay.

The Nodaway soils are moderately well drained. They formed in silty alluvium on frequently flooded bottom lands. The surface layer typically is very dark grayish brown silt loam about 8 inches thick. The substratum, to a depth of about 60 inches, is stratified very dark grayish brown silt loam.

The Muir soils are well drained. They formed in silty alluvium on rarely flooded low terraces. The surface layer typically is very dark brown and very dark grayish brown silty loam about 29 inches thick. The subsoil is dark brown, friable silt loam about 16 inches thick. The substratum, to a depth of about 60 inches, is dark grayish brown silt loam.

The minor soils in this map unit are the frequently flooded, moderately well drained Kennebec soils along creeks; the well drained Tully soils on foot slopes; and the moderately well drained Pawnee soils on side slopes.

The soils in this map unit are mainly used for cultivated crops, but some small areas are used for hay and pasture. Corn, grain sorghum, wheat, and soybeans are the main crops. Flooding is a hazard. Drainage and maintaining tilth and fertility are concerns in management.

These soils have good potential for cultivated crops, range, and woodland and for openland wildlife habitat. They have fair to poor potential for most engineering uses because of flooding.

3. Wymore-Pawnee

Deep, gently sloping and moderately sloping, moderately well drained soils on uplands

This map unit is on ridgetops and side slopes of uplands that are dissected by drainageways and creeks.

This map unit makes up about 66 percent of the county. It is about 44 percent Wymore soils, 34 percent Pawnee soils, and 22 percent minor soils (fig. 1).

The Wymore soils are moderately well drained. They formed in loess on ridgetops and side slopes. The surface layer typically is black silty clay loam about 6 inches thick. The subsoil is about 33 inches thick. The upper part is very dark grayish brown, very firm silty clay. The middle part is grayish brown, mottled, very firm silty clay. The lower part is grayish brown, mottled, firm silty clay loam. The substratum, to a depth of about 60 inches, is grayish brown, mottled, silty clay loam.

The Pawnee soils are moderately well drained. They formed in clayey glacial till on ridgetops and side slopes. The surface layer typically is very dark brown clay loam or clay about 9 inches thick. The subsoil is about 37 inches thick. The upper part is dark brown, firm clay loam. The middle part is dark brown, brown, and dark yellowish brown, mottled, very firm clay. The lower part is yellowish brown, mottled, very firm clay loam. The substratum, to a depth of about 60 inches, is light olive brown, mottled, clay loam.

The minor soils of this map unit are the frequently flooded Kennebec soils along creeks; the somewhat poorly drained Ladysmith soils on broad ridgetops; the well drained, loamy Morrill soils on side slopes; and the well drained Tully soils on foot slopes.

The soils in this map unit are mainly used for cultivated crops, but some small areas are used for hay and pasture. Grain sorghum, wheat, and soybeans are the main crops. Water erosion is a hazard on the gently sloping and moderately sloping areas. Controlling erosion and maintaining tilth and fertility are concerns in management.

These soils have fair to good potential for cultivated crops and for openland wildlife habitat. They have good potential for range and poor to fair potential for most engineering uses because of high shrink-swell potential and low strength.

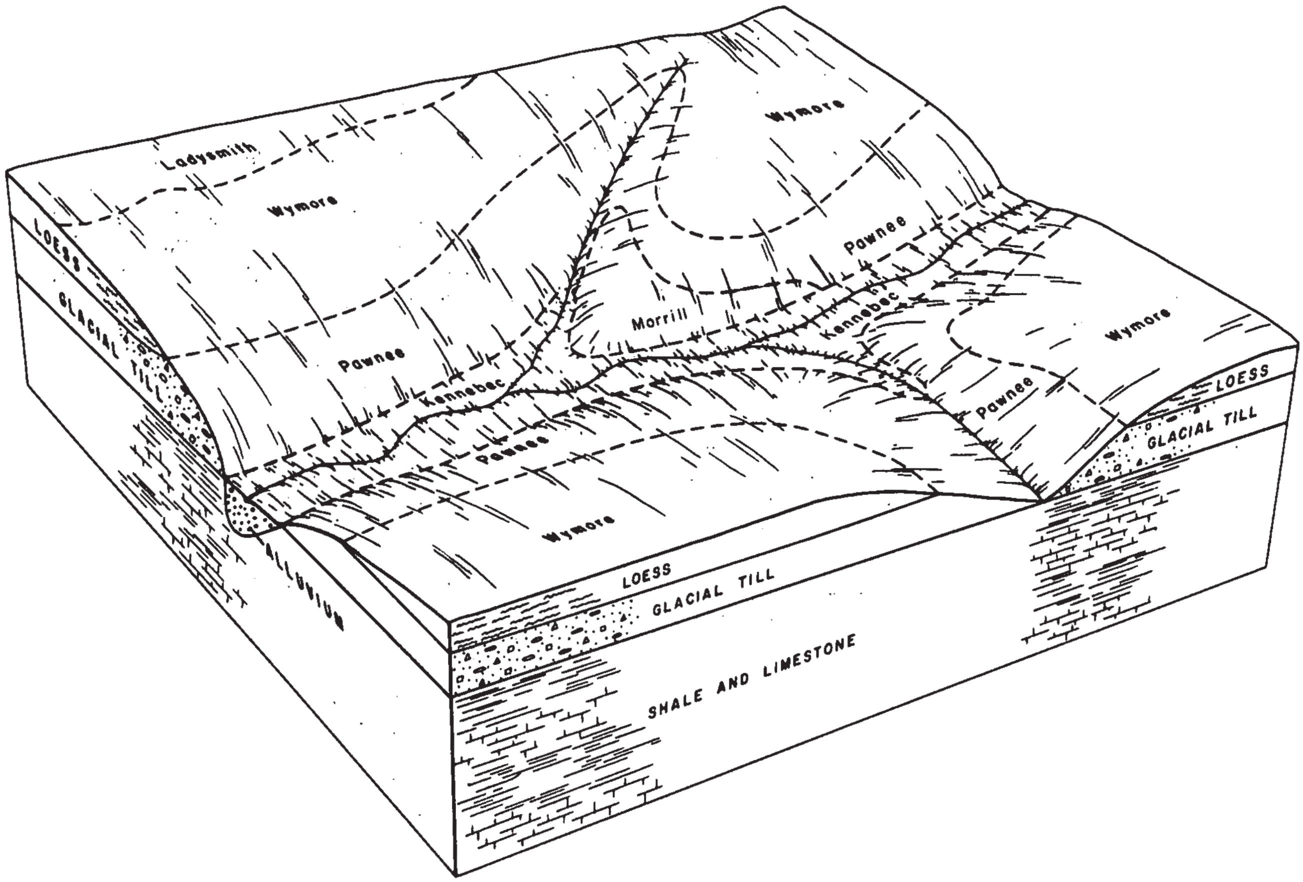


Figure 1.—Typical pattern of soils in Wymore-Pawnee map unit.

4. Wymore-Ladysmith

Deep, gently sloping and nearly level, moderately well drained and somewhat poorly drained soils on uplands

This map unit makes up about 7 percent of the county. It is about 74 percent Wymore soils, 13 percent Ladysmith soils, and 13 percent minor soils.

The Wymore soils are gently sloping and moderately well drained. They formed in loess on ridgetops and side slopes. The surface layer typically is black silty clay loam about 6 inches thick. The subsoil is about 33 inches thick. The upper part is very dark grayish brown, very firm silty clay. The middle part is grayish brown, mottled, very firm silty clay. The lower part is grayish brown, mottled, firm silty clay loam. The substratum, to a depth of about 60 inches, is grayish brown, mottled, silty clay loam.

The Ladysmith soils are nearly level and somewhat poorly drained. They formed in loess and old alluvium on ridgetops and terraces. The surface layer typically is black silty clay loam about 9 inches thick. The subsoil is about 30 inches thick. The upper part is very dark brown, very firm silty clay. The middle part is very dark gray, very firm silty clay. The lower part is olive gray, mottled, firm silty clay loam. The substratum, to a depth of about 60 inches, is olive gray, mottled, silty clay loam.

The minor soils in this map unit are the frequently flooded, moderately well drained Kennebec soils along drainageways; the somewhat excessively drained Kipson soils on side slopes near shale outcrops; and the moderately well drained Pawnee soils on side slopes.

The soils in this map unit are mainly used for cultivated crops, but some small areas are used for range and pasture. Grain sorghum, wheat, and soybeans are the main crops. Water erosion is a hazard on the gently sloping areas. Controlling erosion and maintaining tilth and fertility are concerns in management.

These soils have good potential for cultivated crops and have fair to poor potential for most engineering uses because of high shrink-swell potential and low strength.

5. Pawnee-Shelby-Steinauer

Deep, gently sloping to moderately steep, moderately well drained and well drained soils on uplands

This map unit makes up about 5 percent of the county. It is about 39 percent Pawnee soils, 37 percent Shelby soils, 12 percent Steinauer soils, and 12 percent minor soils.

The Pawnee soils are moderately well drained. They formed in clayey glacial till on ridgetops and side slopes. The surface layer typically is very dark brown clay loam or clay about 9 inches thick. The subsoil is about 37 inches thick. The upper part is dark brown, firm clay loam. The middle part is dark brown, brown, and dark yellowish brown, mottled, very firm clay. The lower part is yellowish brown, mottled, very firm clay loam. The substratum, to a depth of about 60 inches, is light olive brown, mottled, clay loam.

The Shelby soils are moderately well drained. They formed in clay loam glacial till on convex side slopes and narrow ridgetops. The surface layer typically is very dark brown and dark brown clay loam about 17 inches thick. The subsoil is about 31 inches thick. The upper part is brown, firm clay loam. The middle part is mottled, dark yellowish brown clay loam. The lower part is mottled, dark yellowish brown, grayish brown, and light yellowish brown, firm clay loam. The substratum, to a depth of about 60 inches, is mottled, light olive brown clay loam.

The Steinauer soils are well drained. They formed in calcareous clay loam glacial till on convex side slopes. The surface layer typically is very dark grayish brown, calcareous clay loam about 5 inches thick. The next layer is yellowish brown, calcareous, friable clay loam about 13 inches thick. The substratum, to a depth of about 60 inches, is mottled, yellowish brown and pale brown, calcareous clay loam.

The minor soils in this map unit are the frequently flooded, moderately well drained Kennebec soils along drainageways; the rarely flooded, well drained Muir soils on low terraces; and the moderately well drained Wymore soils on gently sloping ridgetops.

About half of the soils in this map unit are used for cultivated crops, and most of the rest is used for range, hay, and pasture. Grain sorghum, wheat, and soybeans are the main crops. Water erosion is a hazard. Controlling erosion and proper range use are concerns in management.

These soils have good potential for range and fair to good potential for openland and rangeland wildlife habitat. They have fair to poor potential for cultivated crops and most engineering uses.

6. Kipson-Tully

Shallow and deep, moderately steep and moderately sloping, somewhat excessively drained and well drained soils on uplands

This map unit makes up about 12 percent of the county. It is about 50 percent Kipson soils, 15 percent Tully soils, and 35 percent minor soils (fig. 2).

The Kipson soils are shallow and somewhat excessively drained. They formed in material weathered from silty, calcareous shales on upland ridges and side slopes. The surface layer typically is very dark grayish brown silty clay loam about 9 inches thick. The next layer is brown, friable, silty clay loam with common fine and medium shale fragments and is about 3 inches thick. The substratum is brown shaly silty clay loam with very pale brown shale at a depth of about 19 inches.

The Tully soils are deep and well drained. They formed in colluvium on foot slopes along drainageways. The surface layer typically is black silty clay loam about 14 inches thick. The subsoil extends to a depth of about 60 inches. The upper part is very dark brown, firm silty clay loam. The middle part is very dark grayish brown, very firm silty clay. The lower part is dark brown and brown, very firm silty clay.

The minor soils in this map unit are the frequently flooded, moderately well drained Kennebec soils along drainageways and the moderately well drained Pawnee and Wymore soils on ridgetops and side slopes. Sogn soils, which formed in material weathered from limestone, are associated with Kipson soils.

The soils in this map unit are mainly used for range, but some small areas are used for cultivated crops. Major concerns of range management are related to the hazard of erosion. Controlling erosion and proper range use are needed.

These soils have fair to good potential for range and for openland and rangeland wildlife habitat. They have fair to poor potential for cultivated crops and most engineering uses.

Soil maps for detailed planning

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil, a brief description of the soil profile, and a listing of the principal hazards and limitations to be considered in planning management.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

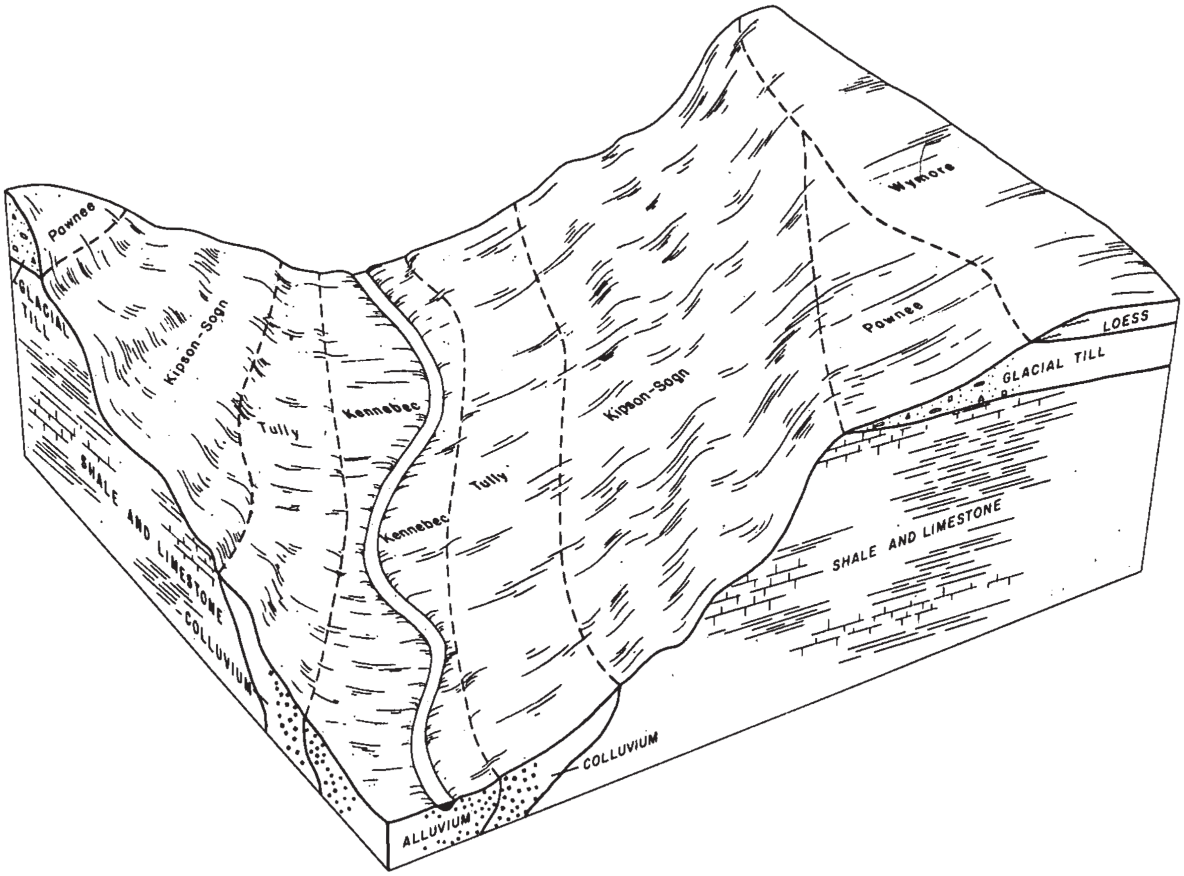


Figure 2.—Typical pattern of soils in the Kipson-Tully map unit.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Pawnee clay loam, 1 to 4 percent slopes, is one of several phases in the Pawnee series.

Some map units are made up of two or more major soils. These map units are called soil complexes, soil associations, or undifferentiated groups. There are no associations or undifferentiated groups in this survey.

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Kipson-Sogn silty clay loams, 5 to 25 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

The names and descriptions of the soils identified on the detailed soil maps for this county do not fully agree with those of the soils identified on the maps for adjacent counties. Differences result from a better knowledge of the soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the counties.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations and capa-

bilities for many uses. The Glossary defines many of the terms used in describing the soils.

Ea—Eudora silt loam. This nearly level, well drained soil is on bottom lands that are rarely or occasionally flooded. Individual areas are irregular in shape and range from 10 to 600 acres.

Typically, the surface layer is very dark brown and very dark grayish brown silt loam about 14 inches thick. The substratum, to a depth of about 60 inches, is dark grayish brown silt loam (fig. 3). In places the surface layer is sandy loam.

Included with this soil in mapping are small areas of moderately well drained Nodaway soils and well drained Muir soils. The Nodaway soils are in lower areas that are frequently flooded, and the Muir soils are on higher terraces that are rarely flooded. These soils make up 5 to 15 percent of the unit.

Figure 3.—Profile of Eudora silt loam. This soil formed in silty alluvium on bottom land.

Permeability is moderate, and available water capacity is high. Surface runoff is slow. Natural fertility is high. Shrink-swell potential is low. The surface layer is friable and easily tilled through a fairly wide range of soil moisture.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, pasture, rangeland, and woodland and for openland and woodland wildlife habitat. This soil has fair potential for most engineering uses.

This Eudora soil is well suited to corn, soybeans, wheat, and grain sorghum, and to grasses and legumes for hay and pasture. Minimum tillage and returning crop residue to the soil help improve fertility, maintain tilth, and increase infiltration.

This soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition.

This soil is well suited to trees, and a few areas remain in native woodland. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by site preparation, controlled burning, spraying, and cutting or girdling. Hazards or limitations are not a concern when planting and harvesting trees.

This Eudora soil has a severe limitation for dwellings because of flooding. Dikes, levees, and other structures help protect the soil from flooding. It has a moderate limitation for septic tank absorption fields and a severe limitation for sewage lagoons because of flooding. It has a severe limitation for local roads and streets because of frost action. The severity of frost action can be reduced by strengthening or replacing the base material.

This soil is in capability class I.

Ga—Geary silt loam, 3 to 7 percent slopes. This moderately sloping, well drained soil is on convex side slopes. Individual areas are irregular in shape and range from 10 to 50 acres.

Typically, the surface layer is very dark brown silt loam about 9 inches thick. The subsoil is about 37 inches thick. The upper part of the subsoil is dark brown silty clay loam. The middle part is brown and reddish brown, firm silty clay loam. The lower part is yellowish red, firm silty clay loam. The substratum, to a depth of about 60 inches, is brown silty clay loam. In places the depth to shale is 40 to 60 inches.

Included with this soil in mapping are small areas of moderately well drained Pawnee and Wymore soils. The Pawnee soils are on the lower part of slopes, and the Wymore soils are on the upper part of slopes and on broad ridgetops above this Geary soil. These inclusions make up 5 to 10 percent of the unit.

Permeability is moderately slow, and available water capacity is high. Surface runoff is medium. Natural fertility is high. Shrink-swell potential is moderate. The sur-

face layer is friable and easily tilled through a fairly wide range of soil moisture.

About half of the areas of this soil are farmed, and most of the rest is in range or pasture. This soil has good potential for range and pasture. It has fair potential for cultivated crops and for openland and rangeland wildlife habitat. This soil has fair potential for most engineering uses.

This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If the soil is used for cultivated crops, there is a hazard of erosion. Minimum tillage, grassed waterways, terraces, and farming on the contour help prevent excessive soil loss. Returning crop residue to the soil helps improve fertility, reduce crusting, and increase infiltration.

This Geary soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition.

This soil has moderate limitations for dwellings because of low strength and moderate shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil and low strength. This soil has a severe limitation for septic tank absorption fields because of moderately slow permeability. Increasing the size of the absorption field and installing perimeter drains around the absorption field help improve the functioning of septic tank systems. This soil has moderate limitations for sewage lagoons because of slope and seepage. Sealing the lagoon helps to reduce seepage. The soil has a severe limitation for local roads and streets because of low strength. The severity of this limitation can be reduced by strengthening or replacing the base material.

This soil is in capability subclass IIIe.

Ka—Kennebec silt loam. This nearly level, moderately well drained soil is on flood plains of streams. It is subject to frequent flooding for brief periods. It is on long, irregularly shaped areas adjacent to stream channels. Areas range from 10 to 160 acres.

Typically, the surface layer is very dark brown silt loam about 34 inches thick. The next layer is very dark grayish brown, friable silt loam about 13 inches thick. The substratum, to a depth of about 60 inches, is dark gray silty clay loam. In places the surface layer is clay loam.

Included with this soil in mapping are small areas of Muir and Tully soils. Muir soils are on alluvial terraces that rarely flood. Tully soils have a clayey subsoil and are on foot slopes of adjacent uplands. These inclusions make up about 2 to 15 percent of this map unit.

Permeability is moderate, and available water capacity is high. Surface runoff is slow. Natural fertility is high. Shrink-swell potential is moderate. The surface layer is friable, and tilth is good. The seasonal high water table is at a depth of 30 to 60 inches, generally from November to May.

About half of the areas of this soil are farmed, and most of the rest is in range or pasture. This soil has good potential for crops, range, pasture, and woodland and for openland and woodland wildlife habitat. It has poor potential for most engineering uses.

This soil is well suited to corn, soybeans, wheat, and grain sorghum and to grasses and legumes for hay and pasture. Minimum tillage and returning crop residue to the soil help improve fertility, maintain tilth, and increase infiltration.

This Kennebec soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition.

This soil is well suited to trees, and a few areas remain in native woodland. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by site preparation, controlled burning, spraying, and cutting or girdling. Hazards or limitations are not a concern when planting and harvesting trees.

This soil has a severe limitation for dwellings, septic tank absorption fields, sewage lagoons, and local roads and streets because of flooding. Dikes, levees, and other structures help protect this soil from flooding.

This soil is in capability subclass IIw.

Kb—Kennebec silt loam, channeled. This nearly level, moderately well drained soil is on flood plains of streams. It is subject to frequent flooding of brief duration. It is on long, irregularly shaped areas dissected by stream channels. Areas range from 10 to 60 acres.

Typically, the surface layer is black silt loam about 32 inches thick. In places the surface layer is silty clay loam. The next layer is very dark gray silt loam about 8 inches thick. The substratum, to a depth of about 60 inches, is very dark gray silty clay loam. Small areas of this soil have free carbonates throughout.

Included with this soil in mapping are small areas of Muir and Tully soils. Muir soils are on alluvial terraces that rarely flood. Tully soils have a clayey subsoil and are on foot slopes of adjacent uplands. These inclusions make up about 2 to 10 percent of this map unit.

Permeability is moderate, and available water capacity is high. Surface runoff is slow, and natural fertility is high. Shrink-swell potential is moderate. The surface layer is friable, and tilth is good. The seasonal high water table is at a depth of 30 to 60 inches, generally from November to May.

Most areas of this soil are in range, pasture, or woodland. This soil has good potential for pasture, range, and woodland and for openland and woodland wildlife habitat. It has poor potential for cultivated crops and most engineering uses.

This soil is poorly suited to cultivated crops. It is dissected by stream channels, leaving small areas that are not readily accessible and that are subject to frequent flooding. This soil is well suited to grasses and legumes for hay and pasture.

This Kennebec soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition.

This soil is well suited to trees, and a few areas remain in native woodland. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by site preparation, controlled burning, spraying, and cutting or girdling. Hazards or limitations are not a concern when planting and harvesting trees.

This soil has a severe limitation for dwellings, septic tank absorption fields, sewage lagoons, and local roads and streets because of flooding. Dikes, levees, and other structures help protect this soil from flooding.

This soil is in capability subclass VIw.

Kc—Kipson-Sogn silty clay loams, 5 to 25 percent slopes. This map unit consists of moderately sloping to moderately steep, somewhat excessively drained soils on upland ridges and side slopes. Individual areas are irregular in shape and range from 20 to more than 1,000 acres. Areas consist of 60 to 75 percent Kipson soil and 10 to 20 percent Sogn soil. The Kipson soil is on narrow convex ridgetops and side slopes along drainageways. The Sogn soil is on broader, less sloping ridgetops and benches. The two soils are so intricately mixed, or areas are so small in size, that it is not practical to separate them in mapping.

Typically, the Kipson soil has a surface layer of very dark grayish brown silty clay loam about 9 inches thick. The next layer is brown, friable silty clay loam that has common fine and medium shale fragments and is about 3 inches thick. The substratum is brown shaly silty clay loam with very pale brown shale at a depth of about 19 inches (fig. 4). In places the soil is clayey below the surface layer, and depth to shale is more than 20 inches.

Typically, the Sogn soil has a surface layer of very dark brown silty clay loam about 14 inches thick. Limestone is at a depth of 14 inches. In some places the soil is calcareous.

Included with these soils in mapping, and making up about 5 to 20 percent of the unit, are small areas of Pawnee, Tully, and Wymore soils, and shale and limestone outcrops. Pawnee, Tully, and Wymore soils have a clayey subsoil and are more than 60 inches deep. Pawnee and Wymore soils are on ridgetops. Tully soils are on foot slopes. Shale outcrops make up some of the steeper areas and breaks. Rock outcrops are at irregular intervals in areas with limestone ledges.

Permeability is moderate for the soils in this map unit. Available water capacity is low for the Kipson soil and very low for the Sogn soil. Surface runoff is rapid. Shrink-swell potential is moderate. The root zone extends to shale or limestone bedrock.

Most areas of these soils are in rangeland. These soils have fair to good potential for range. They have fair potential for pasture, poor potential for cultivated crops, and fair to poor potential for openland and rangeland wildlife habitat and most engineering uses.

The soils in this unit are better suited to range and pasture than to other uses (fig. 5). Major concerns of range management are the hazard of erosion and low and very low available water capacity. The soils are somewhat droughty. Overgrazing reduces the protective cover and causes deterioration of the plant community. Under these conditions the more desirable grasses are replaced by less productive mid and short grasses and weeds. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help keep the range and soil in good condition. Potential pond reservoir sites are few and are confined to areas where the depth to bedrock is not a limitation, generally in drainageways in the less sloping areas.

Because of depth to bedrock, the Kipson soil has a moderate limitation for dwellings without basements and the Sogn soil has a severe limitation. Both soils have

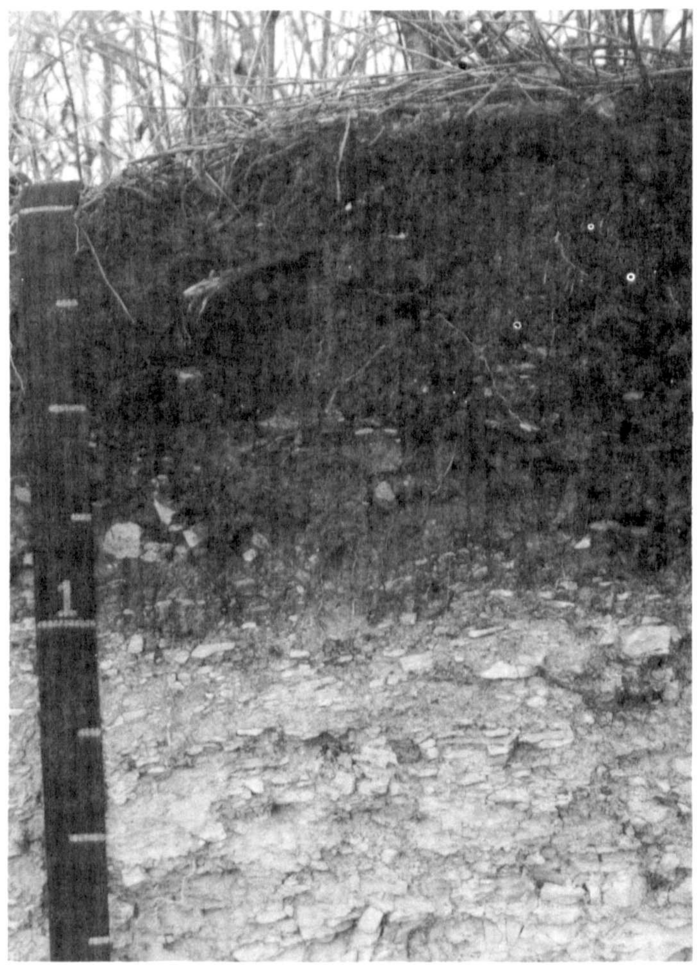


Figure 4.—Profile of Kipson silty clay loam, a shallow soil formed in calcareous shale. Most areas of this soil are in native grass.

Figure 5.—Baled native grass on Kipson-Sogn silty clay loams, 5 to 25 percent slopes.

severe limitations for septic tank absorption fields and sewage lagoons because of the depth to rock and the slopes. However, sewage lagoons can be located on the less sloping, deeper included soils. Because of depth to bedrock, the Kipson soil has a moderate limitation for local roads and streets and the Sogn soil has a severe limitation.

These soils are in capability subclass VIs.

La—Ladysmith silty clay loam. This nearly level, somewhat poorly drained soil is on broad ridgetops and terraces. Individual areas are irregular in shape and range from 30 to several hundred acres.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsoil is about 30 inches thick. The upper part of the subsoil is very dark brown, very firm silty clay. The middle part is very dark gray, very firm silty clay. The lower part is olive gray, mottled, firm silty clay loam. The substratum, to a depth of about 60 inches, is olive gray, mottled silty clay loam. In places the subsoil is browner, and areas are gently sloping.

Permeability is very slow, and surface runoff is slow. The available water capacity, natural fertility, and shrink-swell potential are high. In places this soil has a perched seasonal high water table above the subsoil during wet periods.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, pasture, and rangeland and for openland and rangeland wildlife habitat. It has poor potential for most engineering uses.

This soil is well suited to soybeans, grain sorghum, wheat, and to grasses and legumes for hay and pasture.

The subsoil fails to release water readily for plants, and the soil is droughty during extended periods of low rainfall. Corn and other crops may be damaged during dry periods. Minimum tillage, farming on the contour, and returning crop residue to the soil help to maintain fertility, reduce crusting, and increase infiltration.

This soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition.

This soil has severe limitations for dwellings because of high shrink-swell potential and low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling and low strength. This soil has a severe limitation for septic tank absorption fields because of the very slow permeability. It has slight limitations for sewage lagoons. It has severe limitations for local roads and streets because of low strength and high shrink-swell potential. The severity of these limitations can be reduced by strengthening or replacing the base material.

This soil is in capability subclass IIs.

Ma—Morrill loam, 1 to 4 percent slopes. This gently sloping, well drained soil is on upland ridgetops. Individual areas are irregular in shape and range from 10 to 30 acres.

Typically, the surface layer is very dark brown loam about 12 inches thick. The subsoil is about 31 inches thick. The upper part of the subsoil is very dark grayish brown, friable clay loam. The lower part is reddish brown, firm and friable sandy clay loam. The substratum, to a depth of about 60 inches, is dark brown sandy loam.

Included with this soil in mapping are small areas of Ortello, Pawnee, and Wymore soils. Pawnee and Wymore soils are on the upper part of side slopes. Ortello soils are on the lower part of slopes. These inclusions make up 5 to 15 percent of this unit.

Permeability is moderately slow, and surface runoff is medium. Available water capacity and natural fertility are high. Shrink-swell potential is moderate. The surface layer is friable and easily tilled through a fairly wide range of soil moisture.

About 60 percent of the areas of this soil is farmed, and most of the rest is in range or pasture. This soil has good potential for cultivated crops, range, and pasture and for openland and rangeland wildlife habitat. It has fair to good potential for most engineering uses.

This soil is well suited to small grains, soybeans, and to grasses and legumes for hay and pasture. The areas of this soil that are cultivated have a hazard of soil blowing and water erosion. Minimum tillage, grassed waterways, terraces, contour farming, and a conservation cropping system help prevent excessive soil loss. Returning crop residue to the soil helps to improve fertility, reduce crusting, and increase infiltration.

This Morrill soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition.

This soil is moderately well suited to trees, and a few areas remain in native woodland. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by site preparation, controlled burning, spraying, and cutting or girdling. Hazards or limitations are not a concern when planting and harvesting trees.

This soil has moderate limitations for dwellings because of low strength and a moderate shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil and low strength. This soil has a severe limitation for septic tank absorption fields because of the moderately slow permeability. Increasing the size of the absorption field and installing perimeter drains around the absorption field help improve the functioning of the septic tank systems. This soil has moderate limitations for sewage lagoons because of slope and seepage. Sealing the lagoon helps reduce seepage. This soil has a severe limitation for local roads and streets because of low strength. The severity of this limitation can be reduced by strengthening or replacing the base material.

This soil is in capability subclass IIe.

Mb—Morrill loam, 4 to 8 percent slopes. This sloping, well drained soil is on convex side slopes. Individual areas are irregular in shape and range from 5 to 20 acres.

Typically, the surface layer is very dark brown loam about 12 inches thick. The subsoil is about 31 inches thick. The upper part of the subsoil is very dark grayish brown, friable clay loam. The lower part is reddish brown, firm and friable sandy clay loam. The substratum, to a depth of about 60 inches, is dark brown sandy loam (fig. 6).

Included with this soil in mapping are small areas of Ortello, Pawnee, and Wymore soils. Pawnee and Ortello soils occur anywhere within the areas. Pawnee and Wymore soils are on the upper part of side slopes, and Ortello soils are on the lower part of side slopes. These inclusions make up 5 to 15 percent of the unit.

Permeability is moderately slow, and surface runoff is medium. Available water capacity and natural fertility are high. Shrink-swell potential is moderate. The surface layer is friable and easily tilled through a fairly wide range of soil moisture.

About half of the areas of this soil are farmed, and most of the rest is in range or pasture. This soil has fair potential for cultivated crops. It has good potential for range and pasture and for openland and rangeland wildlife habitat. It has fair to good potential for most engineering uses.

Figure 6.—Profile of Morrill loam, 4 to 8 percent slopes. This soil formed in glacial till.

This soil is moderately well suited to small grains, soybeans, and to grasses and legumes for hay and pasture. If this soil is used for cultivated crops, there is a hazard of erosion. Minimum tillage, grassed waterways, terraces, contour farming, and a conservation cropping system help prevent excessive soil loss. Returning crop residue to the soil helps improve fertility, reduce crusting, and increase infiltration.

This Morrill soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition.

This soil is moderately well suited to trees, and a few areas remain in native woodland. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by site preparation, controlled burning, spraying, and cutting or girdling. Hazards or limitations are not a concern when planting and harvesting trees.

This soil has moderate limitations for dwellings because of low strength and moderate shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil and low strength. This soil has a severe limitation for septic tank absorption fields because of the moderately slow permeability. Increasing the size of the absorption field and installing perimeter drains around the absorption field help improve the functioning of the septic tank systems. This soil has moderate limitations for sewage lagoons because of slope and seepage. Sealing the lagoon helps reduce seepage. This soil has a severe limitation for local roads and streets because of low strength. The severity of this limitation can be reduced by strengthening or replacing the base material.

This soil is in capability subclass IIIe.

Mc—Morrill clay loam, 4 to 8 percent slopes, eroded. This moderately sloping, well drained soil is on convex side slopes. Individual areas are irregular in shape and range from 5 to 30 acres.

Typically, the surface layer is very dark grayish brown clay loam about 8 inches thick. The subsoil is about 24 inches thick. It is reddish brown, friable sandy clay loam. The substratum, to a depth of about 60 inches, is strong brown sandy loam. Pebbles commonly are found on the soil surface.

Included with this soil in mapping are small areas of Ortello, Pawnee, and Wymore soils. Pawnee and Wymore soils are on the upper part of side slopes. Ortello soils are on the lower part of side slopes. These inclusions make up 5 to 15 percent of this unit.

Permeability is moderately slow, and surface runoff is medium. Available water capacity is high. Natural fertility is medium. The surface layer is firm, and tilth is poor. Shrink-swell potential is moderate.

About 60 percent of the areas of this soil is farmed, and most of the rest is in range or pasture. This soil has fair potential for cultivated crops. It has good potential for range and pasture and for openland and rangeland wildlife habitat. It has fair to good potential for most engineering uses.

This soil is moderately well suited to small grains, soybeans, and to grasses and legumes for hay and pasture. If this soil is used for cultivated crops, there is a hazard of continued erosion. Minimum tillage, grassed waterways, terraces, contour farming, and a conservation cropping system help prevent excessive soil loss. Returning crop residue to the soil helps improve fertility, reduce crusting, improve tilth, and increase infiltration.

This Morrill soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition.

This soil is moderately well suited to trees, and a few areas remain in native woodland. Tree seeds, cuttings,

and seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by site preparation, controlled burning, spraying, and cutting or girdling. Hazards or limitations are not a concern when planting and harvesting trees.

This soil has moderate limitations for dwellings because of low strength and moderate shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil and low strength. This soil has a severe limitation for septic tank absorption fields because of the moderately slow permeability. Increasing the size of the absorption field and installing perimeter drains around the absorption field help improve the functioning of the septic tank systems. This soil has moderate limitations for sewage lagoons because of slope and seepage. Sealing the lagoon helps reduce seepage. This soil has a severe limitation for local roads and streets because of low strength. The severity of this limitation can be reduced by strengthening or replacing the base material.

This soil is in capability subclass IIIe.

Me—Muir silt loam. This nearly level, well drained soil is on low terraces that are rarely flooded. Individual areas are irregular in shape and range from 10 to 200 acres.

Typically, the surface layer is very dark grayish brown and very dark brown silt loam about 29 inches thick. The subsoil is dark brown, friable silt loam about 16 inches thick. The substratum, to a depth of about 60 inches, is dark grayish brown silt loam.

Included with this soil in mapping are small areas of well drained Eudora soils, moderately well drained Kennebec and Nodaway soils, and the very poorly drained Wabash soils. The frequently flooded Kennebec and Nodaway soils are near rivers and streams. Eudora soils are adjacent to the rivers. Wabash soils are in shallow depressions and drainageways. These inclusions make up 5 to 20 percent of this unit.

Permeability is moderate, and surface runoff is slow. Available water capacity and natural fertility are high. Shrink-swell potential is low. The surface layer is friable and easily tilled through a wide range of soil moisture.

Most areas of this soil are farmed. This soil has good potential for cultivated crops, pasture, range, and woodland and for openland and rangeland wildlife habitat. It has fair potential for most engineering uses.

This soil is well suited to corn, soybeans, wheat, and grain sorghum, and to grasses and legumes for hay and pasture (fig. 7). Minimum tillage and returning crop residue to the soil help to improve fertility, reduce crusting, and increase infiltration.

This soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition.

This Muir soil is well suited to trees, and a few areas remain in native woodland. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by site preparation, controlled burning, spraying, and cutting or girdling. Hazards or limitations are not a concern when planting and harvesting trees.

This soil has a severe limitation for dwellings because of flooding. Dikes, levees, and other structures help protect the soil from flooding. This soil has a moderate limitation for septic tank absorption fields because of moderate permeability and flooding. This soil has moderate limitations for sewage lagoons because of seepage. Sealing the lagoon helps to control the seepage. It has a moderate limitation for local roads and streets because of low strength. This limitation can be offset by strengthening or replacing the base material.

This soil is in capability class I.

Na—Nodaway silt loam. This nearly level, moderately well drained soil is on flood plains of the rivers. It is subject to frequent flooding. Individual areas are irregular in shape and range from 10 to more than 100 acres.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The substratum, to a depth of about 60 inches, is stratified very dark grayish brown silt loam. In places the surface layer is sandy, and in other places the soil is sandier.

Included with this soil in mapping, and making up about 3 to 15 percent of the unit, are small areas of Eudora, Muir, and Wabash soils. The well drained Eudora and Muir soils are on higher areas. The very poorly drained Wabash soils are in shallow depressions and drainageways.

Permeability is moderate, and surface runoff is slow. Available water capacity and natural fertility are high. The surface layer is friable, and tilth is good. Shrink-swell potential is moderate.

About 80 percent of the areas of this soil is farmed, and most of the rest is in range or pasture. This soil has good potential for cultivated crops, range, pasture, and woodland and for openland and woodland wildlife habitat. It has poor to fair potential for most engineering uses.

This soil is well suited to corn, soybeans, grain sorghum, wheat, and to grasses and legumes for hay and pasture. Minimum tillage and returning crop residue to the soil help improve fertility, reduce crusting, and increase infiltration.

This soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition.

This Nodaway soil is well suited to trees, and a few areas remain in native woodland. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by site preparation, controlled burning, spraying, and cut-

Figure 7.—Sprinkler irrigation of Muir silt loam.

ting or girdling. Hazards or limitations are not a concern when planting and harvesting trees.

This soil has a severe limitation for dwellings, septic tank absorption fields, sewage lagoons, and local roads and streets because of flooding. Dikes, levees, and other structures help protect this soil from flooding.

This soil is in capability subclass IIw.

Oa—Olmitz loam, 1 to 4 percent slopes. This gently sloping, well drained soil is on foot slopes and alluvial fans. Individual areas are irregular in shape and range from 5 to 60 acres.

Typically, the surface layer is very dark brown loam about 21 inches thick and very dark grayish brown clay loam about 8 inches thick. The subsoil, extending to a depth of about 60 inches, is brown, friable clay loam. In places the surface layer is lighter colored.

Included with this soil in mapping, and making up 5 to 10 percent of the unit, are small areas of Muir, Pawnee, Shelby, and Steinauer soils. Muir soils are on the lower part of slopes. Pawnee, Shelby, and Steinauer soils are on the upper part of slopes.

Permeability is moderate, and surface runoff is medium. Available water capacity and natural fertility are high. Shrink-swell potential is moderate. The surface layer is friable and easily tilled.

About 70 percent of the areas of this soil is farmed, and most of the rest is in range or pasture. This soil has good potential for cultivated crops, range, and pasture and for openland and woodland wildlife habitat. It has fair to good potential for most engineering uses.

This soil is well suited to corn, soybeans, small grains, and to grasses and legumes for hay and pasture. If the soil is used for cultivated crops, there is a hazard of

erosion. Minimum tillage, grassed waterways, terraces, and farming on the contour help prevent excessive soil loss. Returning crop residue to the soil helps maintain fertility, reduce crusting, and increase infiltration.

This Olmitz soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition.

This soil has moderate limitations for dwellings because of low strength and moderate shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil and low strength. This soil has a moderate limitation for septic tank absorption fields because of moderate permeability. Increasing the size of the absorption field and installing perimeter drains around the absorption field help improve the functioning of septic tank systems. This soil has moderate limitations for sewage lagoons because of slope and seepage. Sealing the lagoon helps reduce seepage. This soil has a severe limitation for local roads and streets because of low strength. The severity of this limitation can be reduced by strengthening or replacing the base material.

This soil is in capability subclass IIe.

Ob—Ortello sandy loam, 4 to 10 percent slopes. This moderately sloping to strongly sloping, well drained soil is on the side slopes of uplands. Individual areas are irregular in shape and range from 5 to 40 acres.

Typically, the surface layer is very dark brown sandy loam about 20 inches thick. The subsoil is dark brown, very friable fine sandy loam about 16 inches thick. The substratum, to a depth of about 60 inches, is dark brown loamy fine sand.

Included with this soil in mapping, and making up 5 to 10 percent of the unit, are small areas of Morrill, Olmitz, and Pawnee soils. Morrill and Pawnee soils are on the upper part of slopes and are less sloping. Olmitz soils are on foot slopes.

Permeability is moderately rapid, and surface runoff is medium. Available water capacity is moderate. Natural fertility is medium. Shrink-swell potential is low. The surface layer is friable and easily tilled.

About 30 percent of the areas of this soil is farmed, and most of the rest is in range or pasture. This soil has fair potential for cultivated crops. It has good potential for pasture, range, and for rangeland and openland wildlife habitat. This soil has fair to good potential for most engineering uses.

This soil is moderately well suited to corn, soybeans, wheat, and grain sorghum. It is well suited to grasses and legumes for hay and pasture. If the soil is used for cultivated crops, there are hazards of erosion and soil blowing. Minimum tillage, grassed waterways, terraces, and farming on the contour help prevent excessive soil loss. Returning crop residue to the soil helps control soil blowing, maintain fertility, and increase infiltration.

This Ortello soil is well suited to range. Major concerns of range management are the hazard of erosion, soil blowing, and moderate available water capacity. Management that maintains an adequate vegetative cover and ground mulch helps prevent soil blowing, control erosion, and conserve moisture. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition.

This soil has slight limitations for dwellings and septic tank absorption fields. It has severe limitations for sewage lagoons because of seepage and slope. Sealing the lagoon helps reduce seepage. This soil has a moderate limitation for local roads and streets because of frost action. Frost action can be offset by replacing or strengthening the base material.

This soil is in capability subclass IVe.

Pa—Pawnee clay loam, 1 to 4 percent slopes. This gently sloping, moderately well drained soil is on ridgetops and side slopes. Individual areas are irregular in shape and range from 10 to 100 acres.

Typically, the surface layer is very dark brown clay loam about 9 inches thick. The subsoil is about 37 inches thick. The upper part of the subsoil is dark brown, firm clay loam. The middle part is dark brown, brown, and dark yellowish brown, mottled, very firm clay. The lower part is yellowish brown, mottled, very firm clay loam. The substratum, to a depth of about 60 inches, is light olive brown, mottled clay loam. In places the soil is redder.

Included with this soil in mapping, and making up 5 to 10 percent of the unit, are small areas of Kipson, Morrill, Shelby, and Wymore soils. Kipson, Morrill, and Shelby soils are on the lower part of slopes. Wymore soils are on the upper part of slopes.

Permeability is slow, and surface runoff is medium. Available water capacity is moderate. Natural fertility and shrink-swell potential are high. The surface layer is friable and easily tilled through a fairly wide range of soil moisture.

About 80 percent of the areas of this soil is farmed, and most of the rest is in range or pasture. This soil has good potential for cultivated crops, range, and pasture and for openland wildlife habitat. It has poor potential for most engineering uses.

This soil is well suited to corn, soybeans, wheat, and grain sorghum, and to grasses and legumes for hay and pasture. If the soil is used for cultivated crops, there is a hazard of erosion. Minimum tillage, grassed waterways, terraces, and farming on the contour help prevent excessive soil loss. Returning crop residue to the soil helps to maintain fertility, reduce crusting, and increase infiltration.

This Pawnee soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition.

This soil has severe limitations for dwellings because of the high shrink-swell potential and low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil and low strength. This soil has a severe limitation for septic tank absorption fields because of the slow permeability. This soil has a moderate limitation for sewage lagoons because of slope. In places, less sloping areas are suitable for sewage lagoons. This soil has severe limitations for local roads and streets because of low strength, high shrink-swell potential, and frost action. The severity of these limitations can be reduced by strengthening or replacing the base material.

This soil is in capability subclass IIe.

Pb—Pawnee clay loam, 4 to 8 percent slopes. This moderately sloping, moderately well drained soil is on side slopes. Individual areas are irregular in shape and range from 5 to 80 acres.

Typically, the surface layer is very dark brown clay loam about 8 inches thick. The subsoil is about 36 inches thick. The upper part of the subsoil is dark brown, very firm clay. The middle part is brown and dark yellowish brown, mottled, very firm clay. The lower part is yellowish brown, mottled, very firm clay loam. The substratum, to a depth of about 60 inches, is light olive brown, mottled clay. In places the soil is redder.

Included with this soil in mapping, and making up 5 to 10 percent of the unit, are small areas of Kipson, Morrill, Shelby, and Wymore soils. Kipson, Morrill, and Shelby soils are on the lower part of side slopes. Wymore soils are on the upper part of side slopes.

Permeability is slow, and surface runoff is medium. Available water capacity is moderate. Natural fertility and shrink-swell potential are high. The surface layer is friable and easily tilled.

About 60 percent of the areas of this soil is farmed, and most of the rest is in range or pasture. This soil has fair potential for cultivated crops. It has good potential for range and pasture and for openland wildlife habitat. This soil has poor potential for most engineering uses.

This soil is moderately well suited to corn, soybeans, wheat, and grain sorghum, and to grasses and legumes for hay and pasture. If the soil is used for cultivated crops, there is a hazard of erosion. Minimum tillage, grassed waterways, terraces, and farming on the contour help prevent excessive soil loss. Returning crop residue to the soil helps maintain fertility, reduce crusting, and increase infiltration.

This Pawnee soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition.

This soil has severe limitations for dwellings because of the high shrink-swell potential and low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil and low strength. This soil has a severe limitation for septic tank absorption fields because of the slow permeability. This soil has moderate limitations for sewage lagoons because of slope. In places, less sloping areas are suitable for sewage lagoons. This soil has severe limitations for local roads and streets because of low strength, high shrink-swell potential, and frost action. The severity of these limitations can be reduced by strengthening or replacing the base material.

This soil is in capability subclass IIIe.

Pc—Pawnee clay, 3 to 8 percent slopes, eroded. This moderately sloping, moderately well drained soil is on side slopes. Individual areas of this unit are irregular in shape and range from 5 to 30 acres.

Typically, the surface layer is very dark brown clay about 6 inches thick. The subsoil is about 30 inches thick. The upper part of the subsoil is dark brown, very firm clay. The middle part is brown, mottled, very firm clay. The lower part is yellowish brown, mottled, very firm clay loam. The substratum, to a depth of about 60 inches, is light olive brown, mottled clay loam. In places the soils are redder, and in some places the surface layer is clay loam.

Included with this soil in mapping, and making up 5 to 10 percent of the unit, are small areas of Kipson, Morrill, Shelby, and Wymore soils. Kipson, Morrill, and Shelby soils are on the lower part of side slopes. Wymore soils are on the upper part of side slopes.

Permeability is slow, and surface runoff is rapid. Available water capacity is moderate. Natural fertility is medium. Shrink-swell potential is high. The surface layer is firm, and tilth is poor. The surface crusts when dry and puddles when wet. Rills are common, and gullies form in places.

About 70 percent of the areas of this soil is farmed, and most of the rest is in range or pasture. This soil has poor potential for cultivated crops. It has good potential for range and pasture and for openland wildlife habitat. This soil has poor potential for most engineering uses.

This soil is poorly suited to corn, soybeans, wheat, and grain sorghum and to grasses and legumes for hay and pasture. If the soil is used for cultivated crops, there is a hazard of continued erosion. Minimum tillage, grassed waterways, terraces, and farming on the contour help prevent excessive soil loss. Returning crop residue to the soil helps to maintain fertility, soil tilth, reduce crusting, and increase infiltration.

This Pawnee soil is moderately well suited to range. Major concerns of range management are related to past erosion and the hazard of further erosion. Management that maintains an adequate vegetative cover and ground mulch helps control erosion and conserve moisture. Reseeding may be needed on areas of abandoned cropland. Overgrazing reduces the vigor and growth of

the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition.

This soil has severe limitations for dwellings because of the high shrink-swell potential and low strength. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil and low strength. This soil has severe limitations for septic tank absorption fields because of the slow permeability. This soil has a moderate limitation for sewage lagoons because of slope. In places less sloping areas are suitable for sewage lagoons. This soil has severe limitations for local roads and streets because of low strength, high shrink-swell potential, and frost action. The severity of these limitations can be reduced by strengthening or replacing the base material.

This soil is in capability subclass IIIe.

Pd—Pits. Pits is a miscellaneous area from which soil and much of the underlying gravel, sand, or limestone has been removed. The underlying material has been removed for use in concrete, road construction, and agricultural lime. Pits are generally barren areas surrounded by vertical walls. Those without drainage fill with water. Pits too small to be delineated on the soil map are shown by a spot symbol. Most areas of this map unit are barren of vegetation.

Pits is not assigned to a capability class.

Sa—Shelby clay loam, 6 to 10 percent slopes. This moderately sloping, moderately well drained soil is on convex side slopes and narrow ridgetops. Individual areas are irregular in shape and range from 5 to 75 acres.

Typically, the surface layer is very dark brown and dark brown clay loam about 17 inches thick. The subsoil is about 31 inches thick. The upper part of the subsoil is brown, firm clay loam. The middle part is mottled, dark yellowish brown, firm clay loam. The lower part is mottled, dark yellowish brown, grayish brown, and light yellowish brown, firm clay loam. The substratum, to a depth of about 60 inches, is mottled, light olive brown clay loam. In places, carbonates are nearer to the surface.

Included with this soil in mapping, and making up 5 to 10 percent of the unit, are small areas of Morrill, Pawnee, and Steinauer soils. Morrill and Pawnee soils are on the upper part of side slopes. Steinauer soils are on the lower part of side slopes.

Permeability is moderately slow, and surface runoff is rapid. Available water capacity and natural fertility are high. Shrink-swell potential is moderate. The surface layer is friable and easily tilled.

About 70 percent of the areas of this soil is farmed, and most of the rest is in range or pasture. This soil has fair potential for cultivated crops and for openland wildlife habitat. It has good potential for range and pasture and poor to fair potential for most engineering uses.

This soil is moderately well suited to corn, soybeans, small grains, and to grasses and legumes for hay and pasture. If the soil is used for cultivated crops, there is a hazard of erosion Minimum tillage, grassed waterways, terraces, and farming on the contour help prevent excessive soil loss. Returning crop residue to the soil helps to maintain fertility, reduce crusting, and increase water infiltration.

This Shelby soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition.

This soil has moderate limitations for dwellings because of low strength, slope, and moderate shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil and low strength. This soil has a severe limitation for septic tank absorption fields because of moderately slow permeability. Increasing the size of the absorption field and installing perimeter drains around the absorption field help improve the functioning of septic tank systems. This soil has a severe limitation for sewage lagoons because of slope. It has a severe limitation for local roads and streets because of low strength. The severity of this limitation can be reduced by strenghthening or replacing the base material.

This soil is in capability subclass IIIe.

Sb—Steinauer clay loam, 14 to 25 percent slopes. This moderately steep, well drained soil is on convex side slopes. Individual areas are irregular in shape and range from 5 to 60 acres.

Typically, the surface layer is very dark grayish brown, calcareous clay loam about 5 inches thick. The next layer is yellowish brown, calcareous, friable clay loam about 13 inches thick. The substratum, to a depth of about 60 inches, is mottled, yellowish brown and pale brown, calcareous clay loam (fig. 8). In places the depth to calcareous material is greater, and in some places the soil is sandier.

Included with this soil in mapping, and making up 5 to 15 percent of the unit, are small areas of Olmitz and Pawnee soils. Olmitz soils have a thicker surface layer and are on foot slopes. Pawnee soils have a more clayey subsoil and are on the ridges and the upper part of side slopes.

Permeability is moderately slow, and surface runoff is rapid. Available water capacity is high. Natural fertility is medium. Shrink-swell potential is moderate.

Most areas of this soil are in range or pasture. This soil has poor potential for cultivated crops. It has good potential for range and pasture and for rangeland wildlife habitat. This soil has poor potential for most engineering uses.

This Steinauer soil is better suited to range and pas-

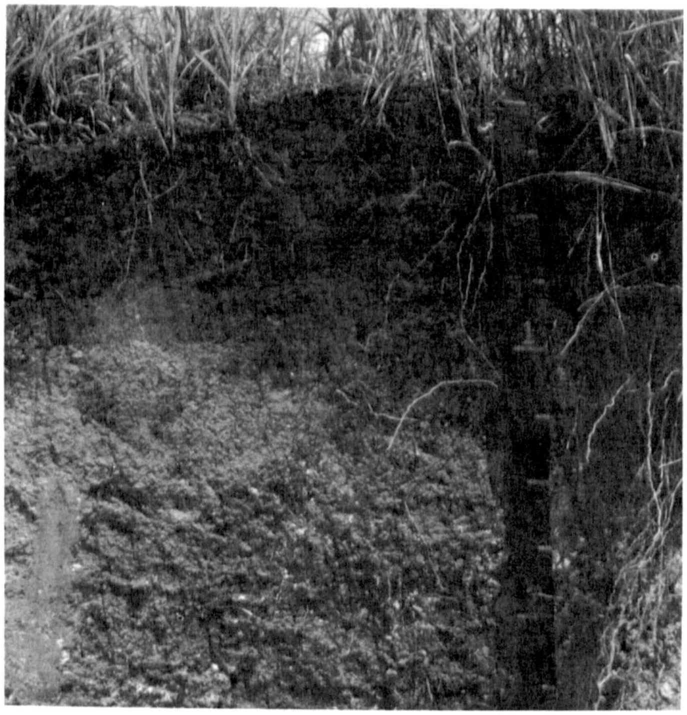


Figure 8.—Profile of Steinauer clay loam. This soil formed in calcareous glacial till.

ture than to other uses. A major concern is the hazard of erosion. Management that maintains an adequate vegetative cover and ground mulch helps prevent excessive soil losses and improves the moisture supplying capacity by reducing runoff. Overgrazing reduces the protective vegetative cover and causes deterioration of the plant community. Under these conditions, the more desirable grasses are replaced by less productive mid and short grasses and weeds. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition. Potential pond reservoir sites are limited.

This soil has a severe limitation for dwellings because of slope. It has severe limitations for septic tank absorption fields because of moderately slow permeability and slope. Increasing the size of the absorption field and installing perimeter drains around the absorption field can improve the functioning of septic tank systems. This soil has a severe limitation for sewage lagoons because of slope. It has severe limitations for local roads and streets because of low strength and slope. The severity of low strength can be reduced by strengthening or replacing the base material.

This soil is in capability subclass VIe.

Sc—Steinauer-Shelby clay loams, 10 to 14 percent slopes. This map unit consists of strongly sloping, well drained and moderately well drained soils on side slopes. Individual areas range from 10 to 100 acres and consist of 45 to 65 percent Steinauer soil and 20 to 30 percent Shelby soil. The Steinauer soil is on the lower part of side slopes and the Shelby soil is on the upper part of side slopes. The two soils are so intricately mixed that it is not practical to map them separately.

Typically, the Steinauer soil has a surface layer of very dark grayish brown, calcareous clay loam about 5 inches thick. The next layer is yellowish brown, calcareous, friable clay loam about 13 inches thick. The substratum, to a depth of about 60 inches, is mottled, yellowish brown and pale brown, calcareous clay loam. The soil is sandier in places.

Typically, the Shelby soil has a surface layer of very dark brown and dark brown clay loam about 17 inches thick. The subsoil is about 31 inches thick. The upper part of the subsoil is brown, firm clay loam. The middle part is mottled, dark yellowish brown, firm clay loam. The lower part is mottled, dark yellowish brown, grayish brown, and light yellowish brown, firm clay loam. The substratum, to a depth of 60 inches, is mottled, light olive brown clay loam. In places, carbonates are nearer the surface.

Included with these soils in mapping, and making up 5 to 15 percent of the unit, are small areas of Olmitz and Pawnee soils. Olmitz soils have a thicker surface layer and are on foot slopes. Pawnee soils have a more clayey subsoil and are on ridges and the upper part of slopes.

Permeability is moderately slow in the Steinauer and Shelby soils. Available water capacity is high. Runoff is rapid, and shrink-swell potential is moderate.

About 70 percent of the areas of these soils is in range and pasture, and most of the rest is farmed. These soils have good potential for range. They have fair potential for growing cultivated crops and poor to fair potential for most engineering uses. The Steinauer soil has good potential for rangeland wildlife habitat, and the Shelby soil has fair potential for openland wildlife habitat.

The soils in this unit are better suited to range and pasture than to other uses. Major concerns are related to the hazard of erosion. Management that maintains an adequate vegetative cover and ground mulch helps prevent excessive soil losses and improves the moisture supplying capacity by reducing runoff. Overgrazing reduces the protective vegetative cover and causes deterioration of the plant community. Under these conditions, the more desirable grasses are replaced by less productive mid and short grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition. Potential pond reservoir sites are limited.

Both soils are moderately well suited to corn, soybeans, small grains, and to grasses and legumes for hay. If the soil is used for cultivated crops, there is a hazard of erosion. Minimum tillage, grassed waterways, terraces, and farming on the contour help prevent excessive soil loss. Returning crop residue to the soil helps maintain fertility, reduce crusting, and increase infiltration.

These soils have moderate limitations for dwellings because of low strength, slope, and moderate shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil and low strength. These soils have a severe limitation for septic tank absorption fields because of moderately slow permeability. Increasing the size of the absorption field and installing perimeter drains around the absorption field improve the functioning of septic tank systems. These soils have a severe limitation for sewage lagoons because of slope, and have a severe limitation for local roads and streets because of low strength. The severity of these limitations can be reduced by strengthening or replacing the base material.

These soils are in capability subclass IVe.

Ta—Tully silty clay loam, 3 to 7 percent slopes. This moderately sloping, well drained soil is on foot slopes along drainageways. Individual areas are irregular in shape and range from 5 to more than 100 acres.

Typically, the surface layer is black silty clay loam about 14 inches thick. The subsoil extends to a depth of about 60 inches. The upper part of the subsoil is very dark brown, firm silty clay loam. The middle part is very dark grayish brown, very firm silty clay. The lower part is dark brown and brown, very firm silty clay. In places the depth to shale is less than 60 inches.

Included with this soil in mapping are small areas of Pawnee, Wymore, Kipson, and Sogn soils. Wymore and Pawnee soils are on the upper part of side slopes. Small areas of Kipson and Sogn soils are in similar positions on the landscape. These inclusions make up about 5 to 10 percent of the unit.

Permeability is slow, and surface runoff is medium. Available water capacity is moderate. Natural fertility and shrink-swell potential are high. The surface layer is friable and easily tilled.

About half of the areas of this soil are farmed, and most of the rest is in range or pasture. This soil has fair potential for cultivated crops. It has good potential for range, pasture, and for openland wildlife habitat. This soil has poor to fair potential for most engineering uses.

This soil is moderately well suited to corn, wheat, grain sorghum, and soybeans, and to grasses and legumes for hay and pasture. If the soil is used for cultivated crops, there is a hazard of erosion. Minimum tillage, grassed waterways, terraces, and contour farming help prevent excessive soil loss. Returning crop residue to the soil helps improve fertility, reduce crusting, and increase water infiltration.

This Tully soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition.

This soil has severe limitations for dwellings because of low strength and high shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil and low strength. This soil has a severe limitation for septic tank absorption fields because of slow permeability. Increasing the size of the absorption field and installing perimeter drains around the absorption field help improve the functioning of septic tank systems. This soil has a moderate limitation for sewage lagoons because of slope. It has severe limitations for local roads and streets because of low strength and high shrink-swell potential. The severity of these limitations can be reduced by strengthening or replacing the base material.

This soil is in capability subclass IIIe.

Tb—Tully silty clay loam, 3 to 7 percent slopes, eroded. This moderately sloping, well drained soil is on foot slopes along drainageways. Individual areas are irregular in shape and range from 5 to 80 acres.

Typically, the surface layer is very dark grayish brown silty clay loam about 5 inches thick. The subsoil extends to a depth of about 60 inches. The upper part of the subsoil is very dark grayish brown, very firm silty clay. The middle part is dark brown, very firm silty clay. The lower part is brown, very firm silty clay. In places, depth to bedrock is less than 60 inches, and in some places the surface layer is silty clay.

Included with this soil in mapping are small areas of Wymore, Pawnee, Kipson, and Sogn soils. Wymore and Pawnee soils are on the upper part of slopes. Small areas of Kipson and Sogn soils are in similar positions on the landscape and have outcrops of limestone and shale. These inclusions make up 5 to 10 percent of the unit.

Permeability is slow, and surface runoff from cultivated areas is rapid. Available water capacity is moderate. Natural fertility is medium. Shrink-swell potential is high. The surface layer is firm, and tilth is poor. The surface crusts when dry and puddles when wet. Rills are common, and gullies form in places.

About half of the areas of this soil are farmed, and most of the rest is in range or pasture. This soil has fair potential for cultivated crops. It has good potential for range and pasture and for openland wildlife habitat. This soil has poor to fair potential for most engineering uses.

This soil is moderately well suited to corn, small grains, soybeans, and to grasses and legumes for hay and pasture. If the soil is used for cultivated crops, there is a hazard of continued erosion. Minimum til age, grassed waterways, terraces, and contour farming help prevent excessive soil loss. Returning crop residue to the soil helps to improve fertility, reduce crusting, and increase infiltration. Soil tilth is hard to maintain.

This Tully soil is well suited to range. Major concerns of range management are related to past erosion and the hazard of further erosion. Management that maintains an adequate vegetative cover and ground mulch

helps control erosion and conserve moisture. Reseeding is needed in places on areas of abandoned cropland. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition.

This soil has severe limitations for dwellings because of low strength and high shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil and low strength. This soil has a severe limitation for septic tank absorption fields because of slow permeability. Increasing the size of the absorption field and installing perimeter drains around the absorption field help improve the functioning of septic tank systems. This soil has a moderate limitation for sewage lagoons because of slope. It has severe limitations for local roads and streets because of low strength and high shrink-swell potential. The severity of these limitations can be reduced by strengthening or replacing the base material.

This soil is in capability subclass IIIe.

Wa—Wabash silty clay loam. This level, very poorly drained soil is on low areas of flood plains that frequently flood. Individual areas are irregular in shape and range from 5 to several hundred acres.

Typically, the surface layer is black silty clay loam about l3 inches thick. In places the surface layer is silty clay. The subsoil, to a depth of about 60 inches, is black, very firm silty clay. In places the subsoil is silty clay loam or silt loam.

Included with this soil in mapping, and making up 5 to 15 percent of the unit, are small areas of well drained Eudora and Muir soils and moderately well drained Nodaway soils. Eudora and Muir soils are on higher areas. Nodaway soils are on the flood plains adjacent to river and stream channels.

Permeability and runoff are very slow. Available water capacity is moderate. During wet years, this soil has a seasonal water table at or near the surface during winter and spring. Natural fertility is high. Shrink-swell potential is high.

Most areas of this soil are farmed, and most of the rest is in range or pasture. This soil has good potential for cultivated crops, range, pasture, and for wetland wildlife habitat. It has fair potential for woodland and poor potential for most engineering uses.

This soil is moderately well suited to corn, soybeans, grain sorghum, wheat, and to grasses and legumes for hay and pasture. The hazard of flooding and the very slow permeability limit the choice of crops and the timeliness of tillage operatons. Minimum tillage and returning crop residue to the soil help maintain fertility, reduce crusting, and increase water infiltration.

This Wabash soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition.

This soil has fair potential for trees. It has severe limitations for equipment use, a severe hazard for plant competition, a moderate hazard for seedling mortality and for windthrow, and a slight hazard of erosion. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. This can be accomplished by site preparation, controlled burning or spraying, and cutting or girdling.

This soil has severe limitations for dwellings and local roads and streets because of wetness, flooding, low strength, and high shrink-swell potential. This soil has severe limitations for septic tank absorption fields because of very slow permeability, flooding, and wetness. It has severe limitations for sewage lagoons because of flooding.

This soil is in capability subclass IIIw.

Wb—Wymore silty clay loam, 1 to 4 percent slopes. This gently sloping, moderately well drained soil is on broad ridgetops. Individual areas are irregular in shape and range from l0 to 400 acres.

Typically, the surface layer is black silty clay loam about 6 inches thick. The subsoil is about 33 inches thick. The upper part of the subsoil is very dark grayish brown, very firm silty clay. The middle part is grayish brown, mottled, very firm silty clay. The lower part is grayish brown, mottled, firm silty clay loam. The substratum, to a depth of about 60 inches, is grayish brown, mottled silty clay loam. In places the surface layer is thicker.

Included with this soil in mapping are small areas of Geary, Pawnee, Tully, and Ladysmith soils. Geary, Pawnee, and Tully soils are on the lower part of slopes. The somewhat poorly drained Ladysmith soils are on nearly level ridgetops. These inclusions make up 5 to 15 percent of the unit.

Permeability is slow, and surface runoff is medium. Available water capacity, natural fertility, and shrink-swell potential are high. The surface layer is friable and easily tilled through a fairly wide range of soil moisture.

Most areas of this soil are farmed, and most of the rest is in range or pasture. The soil has good potential for cultivated crops, pasture, and range. It has fair potential for openland and rangeland wildlife habitat and poor potential for most engineering uses.

This soil is well suited to corn, soybeans, small grains, and to grasses and legumes for hay and pasture. If the soil is used for cultivated crops, there is a hazard of erosion. Minimum tillage, grassed waterways, terraces, and farming on the contour help prevent excessive soil loss. Returning crop residue to the soil helps maintain fertility, reduce crusting, and increase infiltration.

This Wymore soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition.

This soil has severe limitations for dwellings because of low strength and high shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil and low strength. This soil has a severe limitation for septic tank absorption fields because of slow permeability. This soil has a moderate limitation for sewage lagoons because of slope. In places, less sloping areas are suitable for sewage lagoons. This soil has severe limitations for local roads and streets because of low strength, high shrink-swell potential, and frost action. The severity of these limitations can be reduced by strengthening or replacing the base material.

This soil is in capability subclass IIe.

Wc—Wymore silty clay loam, 3 to 6 percent slopes, eroded. This moderately sloping, moderately well drained soil is on side slopes. Individual areas are irregular in shape and range from 5 to 40 acres.

Typically, the surface layer is very dark brown silty clay loam about 4 inches thick. The subsoil is about 29 inches thick. The upper part of the subsoil is very dark grayish brown, very firm silty clay. The middle part is grayish brown, mottled, very firm silty clay. The lower part is grayish brown, mottled, firm silty clay loam. The substratum, to a depth of about 60 inches, is grayish brown, mottled, silty clay loam. In places the surface layer is lighter colored silty clay.

Included with this soil in mapping are small areas of Geary, Pawnee, or Kipson soils. Geary, Pawnee, and Kipson soils are on the lower part of slopes. These inclusions make up about 5 to 15 percent of the unit.

Permeability is slow, and surface runoff is medium. Available water capacity is high. Natural fertility is medium. Shrink-swell potential is high. The surface layer is firm and tilth is poor. The surface crusts when dry and puddles when wet. Rills are common and gullies form in places.

Most areas of this soil are farmed, and most of the rest is in range or pasture. This soil has fair potential for cultivated crops. It has good potential for pasture and range. This soil has fair potential for openland and rangeland wildlife habitat and poor potential for most engineering uses.

This soil is moderately well suited to corn, soybeans, small grain, and to grasses and legumes for hay and pasture. If the soil is used for cultivated crops, there is a continued hazard of erosion. Minimum tillage, grassed waterways, terraces, and farming on the contour help prevent excessive soil loss. Returning crop residue to the soil helps maintain fertility, reduce crusting, and increase water infiltration.

This Wymore soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking rates, uniform distribution of grazing, and deferred grazing help keep the range in good condition.

This soil has severe limitations for dwellings because of low strength and high shrink-swell potential. Using properly designed and reinforced foundations, installing foundation drains, and backfilling with porous material help prevent structural damage caused by shrinking and swelling of the soil and low strength. This soil has a severe limitation for septic tank absorption fields because of slow permeability. It has a moderate limitation for sewage lagoons because of slope. In places, less sloping areas are suitable for sewage lagoons. This soil has severe limitations for local roads and streets because of low strength, high shrink-swell potential, and frost action. The severity of these limitations can be reduced by strengthening or replacing the base material.

This soil is in capability subclass IIIe.

Use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, and trees.

Crops and pasture

Earl J. Bondy, conservation agronomist, Soil Conservation Service, assisted in preparing this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Soil maps for detailed planning." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

Approximately 60 percent of the acreage in Marshall County was used for crops in 1967 according to the Kansas Conservation Needs Inventory (*5*). During a 10 year period ending in 1975, sorghum was produced on approximately 47 percent of the cropland. Wheat was produced on 29 percent, alfalfa on 10 percent, and corn on 7 percent. Oats, barley, and rye constitute minor acreages in the county.

The acreage of sorghum has doubled over the past 10 years as compared to the previous 10 years. Marshall County has ranked first in the state in sorghum production for 7 out of the last 10 years. Soybean acreage has almost doubled but still makes up only 5 percent of the total production. Wheat acreage has remained constant while all other crops have declined in acreage.

Soil erosion is the major problem on 75 percent of the cropland in Marshall County. Where the slope is more than 1 percent, erosion is a hazard. Pawnee and Wymore are the soils dominantly used for crops in the county.

Loss of the surface layer through erosion is damaging for two reasons. First—productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, such as Pawnee and Wymore soils. Second—soil erosion results in sediment entering streams. Control of erosion minimizes the pollution of streams by sediment and improves the quality of water.

Erosion control practices provide protective surface cover, reduce runoff, and increase infiltration. A cropping system that keeps plant cover on the soil for extended periods reduces soil erosion and preserves the productive capacity of the soils.

Terraces and diversions reduce the length of slopes and reduce runoff and erosion. They are most practical on deep, well drained soils that have uniform, regular slopes, which includes practically all of the soils in the county.

Contour tillage should generally be used in combination with terraces (fig. 9). Contour tillage is best suited to those soils that have smooth, uniform slopes and are suitable for terracing.

Leaving crop residue on the surface, either by minimum tillage or stubble mulching, helps increase infiltration and reduce runoff and the hazard of water erosion. The extra cover is essential to help prevent soil blowing. These practices are becoming more common in Marshall County.

Information on the design of erosion control practices is available in the Soil Conservation Service county offices. The latest information and suggestions for growing crops can be obtained from the Cooperative Extension Service or the Soil Conservation Service.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

Land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does

Figure 9.—Contour farming and terraces help to control erosion on Wymore silty clay loam, 1 to 4 percent slopes.

not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

Capability units are soil groups within a subclass. The soils in a capability unit are enough alike to be suited to

the same crops and pasture plants, to require similar management, and to have similar productivity. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-4 or IIIe-6.

Rangeland

Kenneth L. Hladek, range conservationist, Soil Conservation Service, assisted in preparing this section.

Approximately 25 percent of Marshall County is rangeland. More than 35 percent of the agricultural product value in the county is derived from livestock, principally cattle. Yearling operations, traditional to the Bluestem Prairie, are dominantly in the southern part of the county; cow-calf stock farm operations are more prevalent in the northern part.

A large percentage of the livestock operators supplement their rangeland forage with cool season bromegrass pasture and grain sorghum crop residue. During winter, native forage is generally supplemented with hay and protein concentrates.

Soils strongly influence the potential natural plant community for any given area in the county. When the soils receive adequate precipitation, they support a natural plant community dominated by bluestems, switchgrass, and indiangrass. Although the area is predominantly a tall grass prairie, heavy clayey soils interspersed on the nearly level uplands are capable of supporting only a Mixed Prairie natural plant community that is more common to central Kansas.

Traditionally, these prairies are burned in the spring and grazed principally during the summer months by yearling cattle. Fire was an effective means of controlling brush invasion. The early removal of cattle allowed the native grasses adequate time to recover from grazing pressures.

The major concerns for rangeland are the control of grazing, so that the major plant species that make up the natural plant community are either maintained or improved, and the control of brush invasion. Overgrazing has reduced forage production in some areas. The natural plant community has been depleted as a result of excessive, continuous use and brush invasion on prairie uplands.

Manipulating or reducing undesirable brush species and minimizing erosion are important management concerns. Sound range management based on soil survey information and other rangeland inventory information is the basis for maintaining or improving forage production.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 6 shows, for each soil in the survey area, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as or are suited to rangeland are listed. Explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was established during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre reduced to a common percent of air-dry moisture.

Characteristic vegetation—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *composition*, the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only. It does not have a specific meaning that pertains to the present plant community in a given use.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential

meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Woodland management and productivity

Table 7 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed.

In table 7, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *windthrow hazard* are based on soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that a few trees may be blown down by normal winds; *moderate*, that some trees will be blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade where there are openings in the tree canopy. The invading plants compete with native plants or planted seedlings. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* indicates that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed to control undesirable plants.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

Engineering

Franklin C. Kinsey, civil engineer, Soil Conservation Service, assisted in preparing this section.

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and

recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building site development

Table 8 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Sanitary facilities

Table 9 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 9 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 9 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 9 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction materials

Table 10 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill, sand, gravel, and topsoil. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 10 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 14.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water management

Major conservation engineering practices in Marshall County deal with problems of gully and sheet erosion, grade stabilization, and water supply. Waterways, terraces, and grade stabilization structures deal with the problems of erosion and grade stabilization.

Other problems are drainage, flood control, pollution abatement, and irrigation water conservation. Open ditch surface and tile subsurface drainage systems; floodwater retarding dams; agricultural waste management systems; and irrigation water management systems are methods used in solving and controlling these problems.

Farm ponds are used extensively to furnish water for livestock, recreation, and wildlife. Water for livestock is also furnished by the development of springs and wells.

Table 11 gives information on the soil properties and site features that affect water management. It gives for each soil the restrictive features that affect pond reservoir areas, embankments, dikes, and levees; drainage; irrigation; terraces and diversions; and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a

cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity (fig. 10). Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Figure 10.—"Big bales" of bromegrass hay in waterways on Wymore soils. Waterways help to control soil loss by carrying water discharged from terraces off the field.

Recreation

Robert J. Higgins, biologist, Soil Conservation Service, assisted in preparing this section.

Marshall County has several areas of scenic, geologic, and historic interest. Numerous watershed lakes, farm ponds, and streams provide opportunities for water-based recreation on privately-owned land. Areas in the upper reaches of Tuttle Creek Lake are open to the public and provide a place to camp, hunt, fish, and picnic.

Potential for additional development of recreation facilities is good throughout the county.

The soils of the survey area are rated in table 12 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 12, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 12 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 9 and interpretations for dwellings without basements and for local roads and streets in table 8.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife habitat

Robert J. Higgins, biologist, Soil Conservation Service, assisted in preparing this section.

The main game species of Marshall County are bobwhite quail, pheasant, mourning dove, cottontail rabbit, fox squirrel, white-tailed deer, and several species of waterfowl.

Nongame species of wildlife in the county are numerous because of the diverse types of habitat. Cropland, woodland, and pastureland are interspersed throughout the county creating the desirable edge effect conducive to many species. Each of these habitat types provide a home for a particular group of species.

Furbearers are common along many of the streams and trapping is done on a limited basis.

Tuttle Creek Lake, stockwater ponds, streams, and watershed lakes provide good to excellent fishing. Species commonly taken in the county are: bass, channel cat and flathead catfish, carp, and bluegill.

When developing a specific habitat for wildlife, plant cover should be the kind that the soils can produce and should be properly located. Onsite technical assistance in planning wildlife areas and in determining suitable species of vegetation for planting can be obtained from the Soil Conservation Service, Kansas Forestry, Fish and Game Commission, and Extension Service.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 13, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, grain sorghum, wheat, oats, soybeans, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants

are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestems, switchgrass, indiangrass, goldenrod, beggarweed, ragweed, wheatgrass, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, cottonwood, black cherry, black walnut, hackberry, willow, green ash, and hickory. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, plum, fragrant sumac, winterberry, and crabapple.

Coniferous plants furnish browse, seeds, and cones. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, and red cedar.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are gooseberry, dogwood, blackberry, buckbrush, prairie rose, and sumac.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, cattails, saltgrass, prairie cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, owls, thrushes, woodpeckers, squirrels, opossum, raccoon, and white-tailed deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, redwinged blackbirds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include coyotes, badgers, jack rabbits, hawks, dickcissels, and meadowlark.

Soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system

adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and chemical properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Soil and water features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes are not considered flooding.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-

May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An artesian water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A perched water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate*, or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Soil series and morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (*3*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*4*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Soil maps for detailed planning."

Eudora series

The Eudora series consists of deep, well drained, moderately permeable soils on bottom lands. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Eudora soils are similar to Kennebec, Muir, and Nodaway soils and are commonly adjacent to Muir,

Nodaway, and Wabash soils in the landscape. Kennebec and Muir soils have a mollic epipedon that is thicker than 20 inches and a fine-silty control section. Wabash soils have a fine control section. Nodaway soils are typically below the Eudora soils on flood plains. Wabash soils are typically in low, poorly drained areas of the flood plain.

Typical pedon of Eudora silt loam, 820 feet west and 1,390 feet south of the northeast corner of sec. 32, T. 2 S., R. 7 E.

Ap—0 to 5 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable; neutral; abrupt smooth boundary.

A12—5 to 14 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable; neutral; diffuse smooth boundary.

C—14 to 60 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; massive; slightly hard, friable; thin strata of fine sandy loam; neutral.

The thickness of the solum ranges from 10 to 24 inches. Thickness of the mollic epipedon ranges from 10 to 20 inches. Depth of free carbonates ranges from 20 to 60 inches or more.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. It is dominantly silt loam but ranges to very fine sandy loam or fine sandy loam. The C horizon has hue of 10YR, value of 4 to 6 (5 to 7 dry), and chroma of 2. It is silt loam or very fine sandy loam and has thin strata of coarser or finer material.

Geary series

The Geary series consists of deep, well drained soils on uplands. Permeability is moderately slow. These soils formed in silty loess. Slopes range from 3 to 7 percent.

Geary soils are similar to Morrill soils and are commonly adjacent to Pawnee and Wymore soils. Morrill soils have a fine loamy texture, and formed in glacial till. Pawnee and Wymore soils have a fine-textured control section. Pawnee soils also formed in glacial till below Geary soils in the landscape. Wymore soils are typically above Geary soils in the landscape.

Typical pedon of Geary silt loam, 3 to 7 percent slopes, 450 feet south and 830 feet west of the northeast corner of sec. 17, T. 1 S., R. 6 E.

Al—0 to 9 inches; very dark brown (l0YR 2/2) silt loam, very dark grayish brown (l0YR 3/2) dry; moderate fine granular structure; slightly hard, friable; medium acid; gradual smooth boundary.

B1—9 to l6 inches; dark brown (7.5YR 3/2) silty clay loam, brown (7.5YR 4/2) dry; moderate fine subangular blocky structure parting to moderate fine granular; slightly hard, friable; medium acid; gradual smooth boundary.

B21t—16 to 27 inches; brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; moderate fine blocky structure; hard, firm; medium acid; gradual smooth boundary.

B22t—27 to 35 inches; reddish brown (5YR 4/3) silty clay loam, reddish brown (5YR 4/4) dry; moderate fine blocky structure; hard, firm; slightly acid; gradual smooth boundary.

B3—35 to 46 inches; yellowish red (5YR 4/6) silty clay loam, yellowish red (5YR 5/6) dry; weak medium subangular blocky structure; hard, firm; slightly acid; gradual smooth boundary.

C—46 to 60 inches; brown (7.5YR 4/4) silty clay loam, strong brown (7.5YR 5/6) dry; massive; hard, firm; slightly acid.

Thickness of the solum ranges from 30 to 60 inches. Thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It is dominantly silt loam but ranges to silty clay loam. The B1 horizon has hue of 7.5YR or 10YR, value of 2 to 5 (3 to 6 dry), and chroma of 2 to 6. It is dominantly silty clay loam. The B2t horizon has hue of 5YR or 7.5YR, value of 3 to 5 (4 to 6 dry), and chroma of 3 to 6. The B3 and C horizons have hue of 5YR or 7.5YR, value of 4 or 5 (5 to 7 dry), and chroma of 4 to 6. They are silty clay loam or clay loam.

Kennebec series

The Kennebec series consists of deep, moderately well drained, moderately permeable soils on bottom lands. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Kennebec soils are similar to Eudora, Muir,and Nodaway soils, and are commonly adjacent to Muir and Tully soils in the landscape. Eudora soils have a mollic epipedon that is less than 20 inches thick. Muir soils decrease in organic matter content with depth. Nodaway soils do not have a mollic epipedon. Tully soils have a fine textured argillic horizon and are on foot slopes. Muir soils are above the Kennebec soils on low terraces.

Typical pedon of Kennebec silt loam, 1,340 feet south and 70 feet east of the northwest sec. 25, T. 5 S., R. 9 E.

A11—0 to 8 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; neutral; clear smooth boundary.

A12—8 to l9 inches; very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; slightly hard, friable; neutral; diffuse smooth boundary.

A13—19 to 34 inches; very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; weak

fine subangular blocky structure; slightly hard, friable; slightly acid; diffuse smooth boundary.

AC—34 to 47 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; hard, friable; slightly acid; gradual smooth boundary.

C—47 to 60 inches; dark gray (10YR 4/1) silty clay loam, grayish brown (10YR 5/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; massive; hard, firm; neutral.

Thickness of the solum and mollic epipedon is more than 36 inches. Free carbonates are lacking in the solum and typically to a depth of 60 inches or more.

The A and AC horizons have hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. They are dominantly silt loam but range to silty clay loam. The C horizon has hue of 10YR or 2.5YR, value of 2 to 5 (3 to 6 dry), and chroma of 1 or 2. It is silt loam or silty clay loam.

Kipson series

The Kipson series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in silty residuum from calcareous shales. Slopes range from 5 to 25 percent.

Kipson soils are similar to Sogn soils and are commonly adjacent to Pawnee, Sogn, Tully, and Wymore soils in the landscape. Sogn soils have limestone at a depth of less than 20 inches. Pawnee, Tully, and Wymore soils have an argillic horizon and are more than 60 inches deep. Typically, the Pawnee and Wymore soils are above the Kipson soils in the landscape, and the Tully soils are on foot slopes.

Typical pedon of Kipson silty clay loam, in an area of Kipson-Sogn silty clay loams, 5 to 25 percent slopes, 750 feet south and 2,600 feet east of the northwest corner of sec. 2, T. 3 S., R. 7 E.

A1—0 to 9 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable, hard; strong effervescence; moderately alkaline; gradual smooth boundary.

AC—9 to 12 inches; brown (10YR 5/3) silty clay loam, light brownish gray (10YR 6/2) dry; moderate fine subangular blocky structure; hard, friable; common fine and medium shale fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C—12 to 19 inches; brown (10YR 5/3) shaly silty clay loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure in upper part that grades to moderate thin platy structure in lower part; hard, friable; plates are hard and firm; about 15 percent shale fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Cr—19 inches; very pale brown (10YR 7/3) consolidated shales; very hard; strong effervescence.

Thickness of the solum ranges from 6 to 12 inches. Depth to shale ranges from 7 to 20 inches. In some pedons, thin, flat limestone fragments or angular chert fragments are on the soil surface.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. It is dominantly silty clay loam, but the range includes silt loam or clay loam. The AC horizon has the same texture as the A horizon and is intermediate in color between the A and C horizons. The C horizon has hue of 7.5YR, 10YR, or 2.5Y; value of 4 or 5 (5 or 6 dry); and chroma of 2 to 4. Texture is shaly silty clay loam, shaly silt loam, silty clay loam, or silt loam.

Ladysmith series

The Ladysmith series consists of deep, somewhat poorly drained, very slowly permeable soils on uplands. These soils formed in clayey old alluvium or loess. Slopes range from 0 to 1 percent.

Ladysmith soils are similar and commonly adjacent to Wymore soils. Wymore soils typically have steeper slopes and are below the Ladysmith soils.

Typical pedon of Ladysmith silty clay loam, 2,500 feet east and 120 feet south of the northwest corner of sec. 19, T. 1 S., R. 9 E.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; hard, friable; neutral; abrupt smooth boundary.

B21t—9 to 17 inches; very dark brown (10YR 2/2) silty clay, very dark grayish brown (10YR 3/2) dry; moderate fine blocky structure; very hard, very firm; slightly acid; gradual smooth boundary.

B22t—17 to 32 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; moderate fine blocky structure; very hard, very firm; neutral; gradual smooth boundary.

B3—32 to 39 inches; olive gray (5Y 5/2) silty clay loam, light olive gray (5Y 6/2) dry; few medium distinct mottles of yellowish brown (10YR 5/8); weak fine subangular blocky structure; hard, firm; few soft white accumulations of calcium carbonate; mildly alkaline; gradual smooth boundary.

C—39 to 60 inches; olive gray (5Y 5/2) silty clay loam, light gray (5Y 7/2) dry; few fine and medium distinct mottles of yellowish brown (10YR 5/8); massive; hard, firm; few soft white accumulations of calcium carbonate; mildly alkaline.

Thickness of the solum ranges from 36 to 60 inches. Thickness of the mollic epipedon which extends into the Bt horizon ranges from 20 to 40 inches. Depth to carbonate accumulations ranges from 30 to 60 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. It is dominantly silty clay

loam but ranges to silt loam. The B21t horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. It is silty clay or clay. The B22t horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 or 5 dry), and chroma of 1 or 2. It is silty clay or clay. The B3 and C horizons have hue of 10YR, 2.5Y, or 5Y; value of 4 to 6 (5 to 7 dry); and chroma of 1 to 3. The B3 and C horizons range from strongly to weakly mottled with redder hue or higher chroma, or both, than the soil mass. Texture is silty clay loam or silty clay.

Morrill series

The Morrill series consists of deep, well drained soils on uplands. Permeability is moderately slow. These soils formed in glacial till. Slopes range from 1 to 8 percent.

Morrill soils are similar to Geary, Olmitz, and Shelby soils in the landscape. Geary soils formed in loess and have less sand in the control section. Olmitz soils do not have an agrillic horizon. Pawnee soils have more clay in the control section, and Pawnee and Shelby soils do not have redder hue in the Bt horizon. Typically Geary, Pawnee, and Shelby soils are above the Morrill soils; and Ortello soils are below the Morrill soils in the landscape.

Typical pedon of Morrill loam, 4 to 8 percent slopes, 780 feet north and 50 feet east of the southwest corner of sec. 25, T. 2 S., R. 7 E.

A1—0 to 12 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; slightly hard, friable; slightly acid; gradual smooth boundary.

B1—12 to 20 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; hard, friable; medium acid; diffuse boundary.

B2t—20 to 32 inches; reddish brown (5YR 4/4) sandy clay loam, reddish brown (5YR 5/4) dry; weak medium subangular blocky structure; hard, firm; medium acid; gradual smooth boundary.

B3—32 to 43 inches; reddish brown (5YR 4/3) sandy clay loam, reddish brown (5YR 4/4) dry; weak medium subangular blocky structure; hard, friable; medium acid; gradual smooth boundary.

C—43 to 60 inches; dark brown (7.5YR 4/4) sandy loam, strong brown (7.5YR 5/6) dry; massive; soft, very friable; medium acid.

Thickness of the solum ranges from 30 to 60 inches. Thickness of the mollic epipedon ranges from 10 to 24 inches.

The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 to 3. It is dominantly loam but ranges to clay loam or sandy loam. The B1 horizon has hue of 10YR to 5YR, value of 3 or 4 (4 or 5 dry), and chroma of 2 or 3. It is clay loam or loam. The B2t horizon has hue of 7.5YR or 5YR, value of 3 or 4 (3 to 5 dry), and chroma of 3 to 5. It is sandy clay loam or clay loam. The B3 and C horizons have hue of 10YR to 5YR, value of 4 or 5 (4 to 6 dry), and chroma of 3 to 6. Texture is sandy clay loam, clay loam, or sandy loam.

Muir series

The Muir series consists of deep, well drained, moderately permeable soils on low terraces. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Muir soils are similar to Eudora, Kennebec, and Nodaway soils and are commonly adjacent to Eudora, Kennebec, Tully, and Wabash soils in the landscape. Eudora soils have a thinner mollic epipedon and a coarse-silty control section. Kennebec and Nodaway soils have an irregular decrease in organic matter content and are at a lower elevation on the flood plains. The very poorly drained Wabash soils are more clayey and are in low areas. Tully soils are on foot slopes.

Typical pedon of Muir silt loam, 610 feet south and 630 feet east of the center of sec. 17, T. 2 S., R. 7 E.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.

A12—6 to 16 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; slightly acid; gradual smooth boundary.

A3—16 to 29 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak medium granular structure; slightly hard, friable; slightly acid, gradual smooth boundary.

B2—29 to 45 inches; dark brown (10YR 3/3) silt loam, brown (10YR 4/3) dry; moderate medium granular structure; hard, friable; neutral; diffuse smooth boundary.

C—45 to 60 inches; dark grayish brown (10YR 4/2) silt loam, brown (10YR 5/3) dry; weak fine prismatic structure; hard, friable; neutral.

Thickness of the solum ranges from 24 to 48 inches. Thickness of the mollic epipedon ranges from 20 to 48 inches or more. Free carbonates are at a depth of more than 48 inches.

The A horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 1 or 2. It is dominantly silt loam but ranges to silty clay loam or loam. The B2 horizon has hue of 10YR, value of 2 to 4 (4 to 6 dry), and chroma of 2 or 3. It is silt loam, silty clay loam, or loam. The C horizon has hue of 7.5YR or 10YR, value of 3 to 5 (5 to 7 dry), and chroma of 2 to 4. It is silt loam, silty clay loam, loam, or fine sandy loam.

Nodaway series

The Nodaway series consists of deep, moderately well drained, moderately permeable soils on bottom lands. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Nodaway soils are similar to Eudora, Kennebec, and Muir soils and are commonly adjacent to Eudora, Muir, and Wabash soils in the landscape. Eudora, Kennebec, Muir, and Wabash soils have a mollic epipedon. The very poorly drained Wabash soils are more clayey and are in low areas. Eudora and Muir soils are typically above the Nodaway soils on low terraces.

Typical pedon of Nodaway silt loam, 1,930 feet south and 850 feet east of the northwest corner of sec. 17, T. 3 S., R. 7 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable; neutral; abrupt smooth boundary.

C1—8 to 24 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) thinly stratified with light gray (10YR 7/2) dry; massive; slightly hard, friable; neutral; clear smooth boundary.

C2—24 to 33 inches; very dark grayish brown (10YR 3/2) silt loam, dark gray (10YR 4/1) dry; massive; slightly hard, friable; neutral; clear smooth boundary.

C3—33 to 60 inches; very dark grayish brown (10YR 3/2) silt loam, dark gray (10YR 4/1) thinly stratified with light gray (10YR 7/2) dry; massive; slightly hard, friable; neutral.

The Ap horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 1 or 2. It is silt loam. The C horizon has hue of 10YR, value of 3 or 4 (4 to 6 dry), and chroma of 1 or 2. It is silt loam but includes strata of silty clay loam. It commonly is stratified. Some strata have hue of 10YR, value of 4 or 5 (5 to 7 dry), and chroma of 2 to 4. Some pedons are sandy below a depth of 40 inches.

Olmitz series

The Olmitz series consists of deep, well drained, moderately permeable soils on alluvial fans and foot slopes. These soils formed in loamy alluvium. Slopes range from 1 to 4 percent.

Olmitz soils are similar to Morrill and Ortello soils and are commonly adjacent to Muir, Pawnee, and Steinauer soils in the landscape. Muir soils are on low terraces below the Olmitz soils. Ortello soils have a coarse-loamy control section. Pawnee soils have an argillic horizon. Steinauer soils are steeper and have free carbonates at a depth of 8 to 21 inches. Pawnee and Steinauer soils are typically above the Olmitz soils in the landscape.

Typical pedon of Olmitz loam, 1 to 4 percent slopes, 2,350 feet east and 100 feet north of the southwest corner of sec. 14, T. 1 S., R. 10 E.

Ap—0 to 6 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; medium acid; abrupt smooth boundary.

A12—6 to 10 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; medium acid; gradual smooth boundary.

A13—10 to 21 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; medium acid; gradual smooth boundary.

A3—21 to 29 inches; very dark grayish brown (10YR 3/2) clay loam, brown (10YR 4/3) dry; weak fine subangular blocky structure; hard, friable; medium acid; diffuse boundary.

B2—29 to 60 inches; brown (10YR 4/3) clay loam, brown (10YR 5/3) dry; weak fine prismatic structure parting to weak fine subangular blocky; hard, friable; medium acid.

Thickness of the solum ranges from 36 to 60 inches.

The A horizon has hue of 10YR, value of 2 (3 or 4 dry), and chroma of 1 or 2. In some areas Olmitz soils have recent depositions of very dark grayish brown (10YR 3/2) loam. The A horizon is dominantly loam but ranges to clay loam. The B horizon has hue of 10YR, value of 3 or 4 (4 or 5 dry), and chroma of 2 or 3.

Ortello series

The Ortello series consists of deep, well drained soils on uplands. Permeability is moderately rapid. These soils formed in wind deposited sands derived from glacial drift, alluvium, and residuum of mixed mineralogical composition. Slopes range from 4 to 10 percent. The Ortello soils mapped in this survey area are taxadjuncts to the Ortello series because the mollic epipedon is more than 20 inches thick. This difference, however, does not alter their usefulness and behavior.

Ortello soils are similar to Olmitz soils and are commonly adjacent to Morrill, Olmitz, and Pawnee soils in the landscape. Olmitz soils have a fine-loamy control section. Morrill and Pawnee soils have an argillic horizon and are above Ortello soils in the landscape. Olmitz soils are below Ortello soils on foot slopes and alluvial fans.

Typical pedon of Ortello sandy loam, 4 to 10 percent slopes, 2,300 feet south and 50 feet east of the northwest corner of sec. 15, T. 4 S., R. 10 E.

A1—0 to 20 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak medium granular structure; slightly hard, very friable; slightly acid; diffuse smooth boundary.

B2—20 to 36 inches; dark brown (10YR 4/3) fine sandy loam, brown (10YR 5/3) dry; weak medium subangular blocky structure parting to single grain; slightly hard, very friable; few glacial gravel, cobbles, and stones; slightly acid; diffuse smooth boundary.

C—36 to 60 inches; dark brown (10YR 4/3) loamy fine sand, brown (10YR 5/3) dry; single grain; soft, very friable; few glacial gravel, cobbles, and stones; slightly acid.

Thickness of the solum ranges from 16 to 36 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. It is dominantly sandy loam but ranges to loam and loamy sand. The B horizon has hue of 10YR, value of 4 or 5 dry or moist, and chroma of 3 or 4. The C horizon is fine sandy loam or loamy fine sand.

Pawnee series

The Pawnee series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in glacial till. Slopes range from 1 to 8 percent.

Pawnee soils are similar to Tully and Wymore soils and are commonly adjacent to Morrill, Shelby, Tully, and Wymore soils in the landscape. Morrill soils have redder hue and a fine-loamy control section. Shelby soils have a fine-loamy control section. Tully and Wymore soils have less sand in the control section. Wymore soils are typically above Pawnee soils in the landscape. Morrill, Shelby, and Tully soils are typically below Pawnee soils in the landscape.

Typical pedon of Pawnee clay loam, 1 to 4 percent slopes, 2,600 feet east and 50 feet south of the northwest corner of sec. 25, T. 5 S., R. 9 E.

A1—0 to 9 inches; very dark brown (10YR 2/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; hard, friable; medium acid; clear smooth boundary.

B1—9 to 13 inches; dark brown (10YR 3/3) clay loam, brown (10YR 4/3) dry; moderate fine subangular blocky structure; hard, firm; medium acid; gradual smooth boundary.

B21t—13 to 18 inches; dark brown (10YR 3/3) clay, dark yellowish brown (10YR 4/4) dry; common fine distinct yellowish red (5YR 5/6) and dark reddish brown (5YR 3/4) mottles; moderate fine blocky structure; very hard, very firm; slightly acid; gradual boundary.

B22t—18 to 32 inches; brown (10YR 4/3) clay, dark yellowish brown (10YR 4/4) dry; few fine distinct gray (10YR 5/1) and yellowish brown (10YR 5/6) mottles; moderate fine blocky structure; very hard, very firm; neutral; gradual smooth boundary.

B23t—32 to 36 inches; dark yellowish brown (10YR 4/4) clay, yellowish brown (10YR 5/4) dry; common fine distinct olive brown (2.5Y 4/4) mottles; moderate fine blocky structure; very hard, very firm; mildly alkaline; gradual smooth boundary.

B3—36 to 46 inches; yellowish brown (10YR 5/4) clay loam, light yellowish brown (10YR 6/4) dry; few fine distinct gray (10YR 5/1) and faint grayish brown (2.5Y 5/2) mottles; weak medium blocky structure; very hard, very firm; mildly alkaline; gradual smooth boundary.

C—46 to 60 inches; light olive brown (2.5Y 5/4) clay loam, olive yellow (2.5Y 6/6) dry; few fine distinct yellowish brown (10YR 5/4) mottles; moderate medium and coarse blocky structure; very hard, very firm; mildly alkaline.

Thickness of the solum ranges from 36 to 60 inches. Thickness of the mollic epipedon ranges from 10 to 18 inches. A few pebbles are throughout the soil.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 2. It is dominantly clay loam, but the range includes loam and clay. The B2t horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. In some pedons the B3 and C horizons have soft accumulations of lime.

Shelby series

The Shelby series consists of deep, moderately well drained soils on uplands. Permeability is moderately slow. These soils formed in glacial till. Slopes range from 6 to 14 percent.

Shelby soils are similar to Morrill soils and are commonly adjacent to Olmitz, Pawnee, and Steinauer soils in the landscape. Olmitz soils have a thicker A horizon and do not have an argillic horizon. Pawnee soils have a fine-textured argillic horizon, and Morrill soils have redder hue than 7.5YR. Steinauer soils have a thinner solum, do not have an argillic horizon, and have carbonates at a shallower depth. Typically, Pawnee soils are above the Shelby soils, and Olmitz and Steinauer soils are below the Shelby soils in the landscape.

Typical pedon of Shelby clay loam, 6 to 10 percent slopes, 1,850 feet north and 50 feet east of the southwest corner of sec. 14, T. 1 S., R. 10 E.

A1—0 to 13 inches; very dark brown (10YR 2/2) clay loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; slightly hard, friable; neutral; gradual smooth boundary.

A3—13 to 17 inches; dark brown (10YR 3/3) clay loam, brown (10YR 4/3) dry; moderate fine subangular blocky structure; slightly hard, friable; medium acid; gradual smooth boundary.

B21t—17 to 23 inches; brown (10YR 4/3) clay loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; hard, firm; medium acid; gradual smooth boundary.

B22t—23 to 33 inches; dark yellowish brown (10YR 4/4) clay loam, yellowish brown (10YR 5/4) dry; common fine faint light yellowish brown (10YR 6/4) and yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; hard, firm; slightly acid; gradual smooth boundary.

B3—33 to 48 inches; mottled dark yellowish brown (10YR 4/4), grayish brown (10YR 5/2), and light

yellowish brown (10YR 6/4) clay loam; weak medium blocky structure; hard, firm; neutral; gradual smooth boundary.

C—48 to 60 inches; light olive brown (2.5Y 5/4) clay loam, light brownish gray (2.5Y 6/2) dry; common medium distinct brownish yellow (10YR 6/6) and strong brown (7.5YR 5/6) mottles; massive; hard, firm; violent effervescence, moderately alkaline.

Thickness of the solum and the depth to free carbonates range from 40 to 60 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. It is dominantly clay loam but ranges to loam and silt loam. The B2t and B3 horizons have hue of 10YR, value of 4 or 5 (5 or 6 dry), and chroma of 3 or 4. Texture is clay loam.

Sogn series

The Sogn series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in residuum from the underlying limestone. Slopes range from 5 to 10 percent (fig. 11).

Sogn soils are similar to Kipson soils and are commonly adjacent to Kipson, Pawnee, and Wymore soils in the landscape. Kipson soils have calcareous shale at a depth of less than 30 inches. Kipson soils are both below and above the Sogn soils in the landscape. The deep Pawnee and Wymore soils have an argillic horizon and typically are above the Sogn soils in the landscape.

Figure 11.—Profile of Sogn silty clay loam, a shallow soil formed in material weathered from limestone. This soil is used for rangeland.

Typical pedon of Sogn silty clay loam, in an area of Kipson-Sogn silty clay loam, 5 to 25 percent slopes, 1,500 feet east and 50 feet north of the center of sec. 4, T. 3 S., R. 7 E.

A1—0 to 14 inches; very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) dry; moderate medium subangular blocky structure; hard, friable; mildly alkaline; abrupt smooth boundary.

R—14 inches; limestone.

Thickness of the solum and depth to limestone range from 4 to 20 inches.

The A horizon has hue of 7.5YR, 10YR, or 2.5Y; value of 2 or 3 (3 to 5 dry); and chroma of 1 to 3. It is dominantly silty clay loam but ranges to loam and silt loam. Some pedons contain fragments of limestone that make up less than 35 percent of the soil volume.

Steinauer series

The Steinauer series consists of deep, well drained soils on uplands. Permeability is moderately slow. These soils formed in calcareous glacial till. Slopes range from 10 to 25 percent.

Steinauer soils are commonly adjacent to Olmitz, Pawnee, and Shelby soils in the landscape. Olmitz and Shelby soils are leached of carbonates to a greater depth. Pawnee and Shelby soils have an argillic horizon. Typically Pawnee and Shelby soils are on a smoother, less sloping landscape above the Steinauer soils. Olmitz soils are typically below the Steinauer soils in the landscape.

Typical pedon of Steinauer clay loam, in an area of Steinauer-Shelby clay loams, 10 to 14 percent slopes, 1,500 feet north and 50 feet east of the southwest corner of sec. 14, T. 1 S., R. 10 E.

A1—0 to 5 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; weak fine granular structure; slightly hard, friable; strong effervescence; moderately alkaline; gradual smooth boundary.

AC—5 to 18 inches; yellowish brown (10YR 5/4) clay loam, pale brown (10YR 6/3) dry; weak fine subangular structure; slightly hard, friable; strong effervescence; moderately alkaline; gradual smooth boundary.

C1—18 to 32 inches; yellowish brown (10YR 5/4) clay loam, light yellowish brown (10YR 6/4) dry; few stones and pebbles; massive; slightly hard, friable: common medium faint brownish yellow (10YR 6/6) mottles; violent effervescence; common soft white accumulations of carbonates; moderately alkaline; gradual smooth boundary.

C2—32 to 60 inches; pale brown (10YR 6/3) clay loam, very pale brown (10YR 7/3) dry; few stones and pebbles; massive; hard, firm; few fine distinct strong brown (7.5YR 5/6) mottles, and common medium distinct yellowish brown (10YR 5/6) mottles; violent effervescence; common soft white accumulations of carbonates; moderately alkaline.

Thickness of the solum ranges from 8 to 21 inches. Free carbonates are near the surface to a depth of about 14 inches.

The A horizon has hue of 10YR, value of 4 or 5 (5 or 6 dry), and chroma of 2 to 4. It is dominantly clay loam but ranges to loam. The AC horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 or 6 dry), and chroma of 2 to 4. The C horizon is clay loam and contains seams or pockets of sand, stones, or gravel. Stones, pebbles, lime masses, and iron concretions vary in size and amounts from place to place.

Tully series

The Tully series consists of deep, well drained, slowly permeable soils on foot slopes. These soils formed in colluvial material weathered from shale. Slopes range from 3 to 7 percent.

Tully soils are similar to Pawnee and Wymore soils and are commonly adjacent to Kipson, Pawnee, and Wymore soils in the landscape. Kipson soils are shallow to shale. Pawnee soils contain more sand in the control section. Wymore soils formed in loess and have a thinner A horizon. Typically, the Kipson, Pawnee, and Wymore soils are above Tully soils in the landscape.

Typical pedon of Tully silty clay loam, 3 to 7 percent slopes, 1,140 feet east and 960 feet south of the northwest corner of sec. 34, T. 2 S., R. 7 E.

A1—0 to 14 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; slightly hard, friable; neutral; clear smooth boundary.

B1—14 to 19 inches; very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) dry; moderate fine subangular blocky structure; hard, firm; slightly acid; clear smooth boundary.

B21t—19 to 28 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; moderate fine blocky structure; very hard, very firm; slightly acid; gradual smooth boundary.

B22t—28 to 55 inches; dark brown (10YR 4/3) silty clay, brown (10YR 5/3) dry; few fine faint strong brown (7.5YR 5/6) mottles; moderate medium prismatic sturcture parting to moderate medium blocky; very hard, very firm; neutral; gradual smooth boundary.

B3—55 to 60 inches; brown (10YR 4/3) silty clay, pale brown (10YR 6/3) dry; moderate medium prismatic sturcture; very hard, very firm; mildly alkaline.

Thickness of the solum ranges from 36 to 60 inches. Thickness of the mollic epipedon ranges from 20 to 36 inches.

The A and B1 horizons have hue of 10YR or 7.5YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 to 3. The A horizon is dominantly silty clay loam but ranges to silt loam and clay loam. The B1 horizon is silty clay loam or clay loam. The B21t horizon has hue of 10YR or 7.5YR, value of 3 (4 to 5 dry), and chroma of 2 or 3. The B22t and B3 horizons have hue of 10YR or 7.5YR, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. The B2t horizon is silty clay or clay. The C horizon has hue of 10YR, 7.5YR, or 5YR; value of 3 to 5 (4 to 6 dry); and chroma of 2 to 4. Some pedons contain concretions of calcium carbonate below a depth of 30 inches.

Wabash series

The Wabash series consists of deep, very poorly drained, very slowly permeable soils on flood plains. These soils formed in clayey alluvial sediment. Slopes are less than 1 percent (fig. 12).

Wabash soils are commonly adjacent to Kennebec, Muir, and Nodaway soils. Kennebec and Nodaway soils have a fine-silty control section, and an irregular decrease in organic matter content. They are at lower elevations on the flood plains. Muir soils have a fine-silty control section and are at higher elevations on low terraces.

Typical pedon of Wabash silty clay loam, 600 feet south and 20 feet west of the northeast corner of sec. 8, T. 4 S., R. 10 E.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; slightly hard, friable; neutral; abrupt smooth boundary.

A12—8 to 13 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; few fine faint dark gray (5Y 4/1) mottles; moderate fine blocky structure; hard, firm; slightly acid; gradual smooth boundary.

B1g—13 to 28 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry, few fine faint dark gray (5Y 4/1) mottles; strong fine blocky structure; extremely hard, very firm; slightly acid; diffuse smooth boundary.

B2g—28 to 60 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; extremely hard, very firm; neutral.

Thickness of the solum ranges from 40 to more than 60 inches.

The A and B horizons have hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 2 or less. Some pedons contain carbonates at a depth of more than 40 inches. The control section averages between 46 and 60 percent clay.

Figure 12.—Ponded water on Wabash silty clay loam. This soil has very slow permeability and is very poorly drained.

Wymore series

The Wymore series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in loess. Slopes range from 1 to 6 percent.

Wymore soils are similar to Ladysmith, Pawnee, and Tully soils and are commonly adjacent to Ladysmith, Morrill, Pawnee, and Tully soils. Morrill soils have redder hue in the B horizon. The Ladysmith soils are somewhat poorly drained. Pawnee soils contain more sand throughout their solum. Tully soils have a thicker mollic epipedon and formed in residuum from shale. Typically, Ladysmith soils are above Wymore soils, and Morrill and Pawnee soils are below Wymore soils in the landscape. Tully soils are on foot slopes.

Typical pedon of Wymore silty clay loam, 1 to 4 percent slopes, 850 feet west and 620 feet north of the southeast corner of sec. 18, T. 1 S., R. 9 E.

Ap—0 to 6 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; hard, firm; medium acid; abrupt smooth boundary.

B21t—6 to 18 inches; very dark grayish brown (10YR 3/2) silty clay, grayish brown (10YR 5/2) dry; moderate fine blocky structure; very hard, very firm; slightly acid; gradual smooth boundary.

B22t—18 to 26 inches; grayish brown (10YR 5/2) silty clay, light brownish gray (10YR 6/2) dry; few fine distinct very dark gray (10YR 3/1) and yellowish brown (10YR 5/6) mottles; moderate fine blocky structure; very hard, very firm; neutral; gradual smooth boundary.

B3—26 to 39 inches; grayish brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; many medium prominent yellowish red (5YR 5/8) and dark reddish brown (5YR 3/4) mottles; weak medium blocky structure; hard, firm; neutral; diffuse smooth boundary.

C—39 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; common medium prominent dark reddish brown (5YR 3/3) mottles; massive; hard, firm; mildly alkaline.

Thickness of the solum ranges from 36 to 50 inches. Thickness of the mollic epipedon, which extends into the B2t horizon, ranges from 12 to 18 inches.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. It is silty clay loam. The B2t horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 or 5 dry), and chroma of 2 to 4, with darker colors in the upper part. The B3 and C horizons have hue of 10YR or 2.5Y, value of 4 or 5 (5 or 6 dry), and chroma of 2 to 4. Texture is silty clay loam or silty clay. The lower part of the B horizon is strongly to weakly mottled. In some pedons a few lime concretions are at a depth of 30 to 50 inches.

Classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*4*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 17, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udoll (*Ud*, meaning humid, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Argiudolls (*Argi*, meaning argillic plus *udoll*, the suborder of the Mollisols that have an udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Argiudolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, mesic Typic Argiudolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Factors of soil formation

Soil is produced by soil-forming processes acting on material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by: (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rock and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Time is required for changing the parent material into a soil profile. Usually a long time is required for the formation of distinct horizons.

Factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many processes of soil formation are unknown.

Parent material

Parent material of most soils on uplands in the survey area is material weathered from loess, glacial till, and bedrock. Soils on the bottom land developed in alluvium.

Loess is windblown material that was deposited over most of the county. Loess deposits consist of relatively uniform, fine material that is mostly silt and clay. Loess of several different ages is in the survey area. Loveland Loess was deposited during the Illinoian and early Sangamonian stages of Pleistocene time. The Geary soils developed in this loess on uplands, mainly in the northwestern part of the county. Peoria Loess was deposited during the Wisconsin stage of Pleistocene time. Ladysmith and Wymore soils developed in Peoria Loess. Peoria Loess deposits are in all parts of the survey area.

Glacial till of the Kansan age is the parent material of some soils on the upland ridges and slopes in Marshall County. The till is a fine earth mixture of silt, sand, and clay. It also contains pebbles and, in places, stones or quartzite boulders. Thin layers or pockets of sand and gravel occur within the till. Till deposits are in all parts of Marshall County. Morrill, Ortello, Pawnee, Shelby, and Steinauer soils formed in glacial till.

Most layers of the consolidated bedrock that crops out in Marshall County are members of the Permian System.

These bedrock layers are alternate strata of shale and limestone. Some of the weathering material was transported short distances downhill by water and gravity before much soil development took place. The main soils that developed in material weathered from these rocks are Kipson and Sogn soils.

Alluvium consists of sediments deposited by rivers and streams on the bottom land in Marshall County. Alluvium is a heterogenous mixture of silt, clay, and sand washed from upland areas, carried by water, and deposited by rivers and streams. It covers the bottom land and foot slopes in Marshall County in various thicknesses. Soils that formed in alluvium differ according to their source, whether sandy, silty, or clayey. The soils also differ in drainage characteristics. Soils that developed in alluvium are Eudora, Kennebec, Muir, Nodaway, Olmitz, and Wabash soils.

Climate

Climate affects soil formation and weathering by changes in temperature, amount of rainfall, periods of high and low rainfall causing wetting and drying of the soil, humidity, and winds. The effects of climate are somewhat modified by kind of parent material, relief, and plant and animal life.

Long cold periods of high precipitation produced the glaciation that advanced into Marshall County and covered most of the area with glacial material. Dry and windy periods produced the dust and caused the accumulations of loess. There were also stable periods of weathering and soil formation.

Parent material undergoes changes in compostiion, color, and structure. Leaching occurs; oxidation, reduction, and other weathering processes also occur. Organic matter is accumulated in the soil. Clay removed from the surface layer accumulates in the subsoil. There is a partial removal of lime and other minerals from the surface layer and from the upper part or all of the subsoil.

Climate also determined the rate of geologic erosion, which affected the relief in the county and the removal of differing amounts of soil and parent material. Loess was removed from the slopes, exposing the glacial till in which the Morrill, Ortello, Pawnee, Shelby, and Steinauer soils formed. The glacial till was removed from slopes in areas exposing the parent material in which Kipson and Sogn soils formed. Material was deposited on the bottom lands in which Eudora, Kennebec, Muir, Nodaway, and Wabash soils formed.

Plant and animal life

Soil formation is influenced by plant and animal life. Most of the soils in Marshall County formed under grass and are dark colored because of the accumulation of organic matter in the surface layer and upper part of the subsoil. The grass, dominantly bluestem prairies, produced large amounts of organic matter that was added to the soil. The deep rooted grasses also extracted minerals such as calcium from the subsoil and returned them to the surface through their roots, stems, and leaves. This process tends to renew the basic elements in the upper part of the soil.

Man and animal life also have a decided influence. Man alters the soil by tilling, improving drainage, adding elements and organic matter, and by choosing certain plants. Ants, earthworms, and burrowing animals generally have beneficial effect on soil aeration, fertility, permeability, and structure. They mix the organic matter and mineral components of the soil, increasing the depth of organic matter accumulation. They also supply fresh minerals by bringing parent material to the upper part of the soil. Micro-organisms break down the organic matter, improve soil tilth, and fix nitrogen in the soil, thus increasing fertility. The kinds and number of organisms and their activity vary according to the conditions of the soil and differences in the kinds of vegetation.

Relief

Soils in Marshall County show the effects of relief in thickness, color, and degree of development of their profiles. Relief affects soil formation mainly through its effects on drainage, runoff, erosion, and plant cover. The amount of water that penetrates the soil partly depends upon topography.

Nearly level and gently sloping soils have a thicker, darker surface layer; and carbonates are at a greater depth. The soils also have distinct horizons and a thicker solum than moderately steep soils. Erosion on nearly level and gently sloping soils is less than on moderately steep soils. Nearly level and gently sloping soils generally produce more vegetation than moderately steep soils because the amount of available water is greater.

Time

The length of time soil material is subjected to weathering is reflected in the degree of profile development.

Kennebec and Nodaway soils are examples of young soils that formed in alluvium. They formed in alluvium deposits so recently that distinct horizons have not had time to develop. New material is being deposited by overflow from adjacent streams and rivers. Distinct horizons are not likely to develop, even over a long period of time. Kipson soils, on rather steep slopes, do not have distinct horizons because of high runoff, and soil material is removed as fast as it forms. Wymore soils are older, on more stable landscapes, and have been in place long enough for well defined horizons to form.

References

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for

highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.
(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.
(3) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962]
(4) United States Department of Agriculture. 1975. Soil taxonomy: a basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.
(5) United States Department of Agriculture. 1967. Kansas conservation needs inventory. 191 pp., illus.

Glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	More than 12

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Calcareous soil. A soil containing encugh calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods

during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Parent material. The unconsolidated organic and mineral material in which soil forms.

Percolation. The downward movement of water through the soil.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the low lands along streams.

TABLES

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Data recorded at Marysville, 1949-1970]

Month	Temperature					Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	In	In	In		In
January----	35.4	13.1	24.2	66	-13	0.83	0.10	1.36	2	4.6
February---	42.0	18.5	30.3	71	- 9	0.97	0.39	1.66	2	5.3
March------	49.8	26.0	37.9	84	1	1.69	0.51	2.45	3	4.3
April------	65.3	39.4	52.4	92	19	2.59	1.27	3.72	5	0.5
May--------	76.1	51.7	63.9	95	30	4.41	2.59	6.15	7	0.0
June-------	85.0	61.4	73.2	103	43	4.71	2.82	6.26	8	0.0
July-------	90.9	66.2	78.5	107	50	4.28	1.72	6.80	6	0.0
August-----	89.7	64.2	77.0	105	48	4.05	2.51	6.10	6	0.0
September--	80.7	54.1	67.4	101	32	3.67	1.58	5.93	7	0.0
October----	70.2	42.5	56.4	95	22	2.28	0.77	3.79	4	0.1
November---	52.8	28.2	40.5	79	4	1.00	0.13	1.79	2	1.5
December---	40.7	18.5	29.6	68	- 8	0.81	0.28	1.32	2	3.3
Year-----	64.9	40.3	52.6	107	-13	31.29	24.61	35.21	54	19.6

TABLE 2.--FREEZE DATES IN SPRING AND FALL

Probability	Minimum temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 14	April 28	May 12
2 years in 10 later than--	April 9	April 21	May 7
5 years in 10 later than--	March 31	April 13	April 27
First freezing temperature in fall:			
1 year in 10 earlier than--	October 17	October 10	September 29
2 years in 10 earlier than--	October 21	October 15	October 3
5 years in 10 earlier than--	October 31	October 24	October 13

TABLE 3.--GROWING SEASON

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	194	171	146
8 years in 10	201	179	154
5 years in 10	214	194	169
2 years in 10	228	210	185
1 year in 10	235	217	193

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Ea	Eudora silt loam	8,400	1.4
Ga	Geary silt loam, 3 to 7 percent slopes	1,300	0.2
Ka	Kennebec silt loam	34,900	6.0
Kb	Kennebec silt loam, channeled	1,950	0.3
Kc	Kipson-Sogn silty clay loams, 5 to 25 percent slopes	55,700	9.6
La	Ladysmith silty clay loam	8.100	1.4
Ma	Morrill loam, 1 to 4 percent slopes	850	0.2
Mb	Morrill loam, 4 to 8 percent slopes	2,600	0.5
Mc	Morrill clay loam, 4 to 8 percent slopes, eroded	4,700	0.8
Me	Muir silt loam	16,200	2.8
Na	Nodaway silt loam	10,100	1.7
Oa	Olmitz loam, 1 to 4 percent slopes	1,950	0.3
Ob	Ortello sandy loam, 4 to 10 percent slopes	600	0.1
Pa	Pawnee clay loam, 1 to 4 percent slopes	64,800	11.1
Pb	Pawnee clay loam, 4 to 8 percent slopes	17,500	3.0
Pc	Pawnee clay, 3 to 8 percent slopes, eroded	67,100	11.5
Pd	Pits	362	0.1
Sa	Shelby clay loam, 6 to 10 percent slopes	13,900	2.4
Sb	Steinauer clay loam, 14 to 25 percent slopes	1,700	0.3
Sc	Steinauer-Shelby clay loams, 10 to 14 percent slopes	6,400	1.1
Ta	Tully silty clay loam, 3 to 7 percent slopes	11,300	1.9
Tb	Tully silty clay loam, 3 to 7 percent slopes, eroded	15,900	2.7
Wa	Wabash silty clay loam	12,400	2.1
Wb	Wymore silty clay loam, 1 to 4 percent slopes	177,700	30.5
Wc	Wymore silty clay loam, 3 to 6 percent slopes, eroded	28,900	5.0
	Water*	17,728	3.0
	Total	583,040	100.0

*Most of the water area is the flood pool of the Tuttle Creek Reservoir. The soils in most of these areas are used as cropland. They are dominantly Eudora, Nodaway, and Wabash soils.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Grain sorghum	Winter wheat	Corn	Soybeans	Alfalfa hay	Smooth bromegrass
	Bu	Bu	Bu	Bu	Ton	AUM*
Ea Eudora	90	48	95	40	5.0	6.5
Ga Geary	70	38	70	30	3.5	5.5
Ka Kennebec	90	44	95	35	5.0	6.5
Kb Kennebec	---	---	---	---	---	---
Kc. Kipson	---	---	---	---	---	---
Sogn	---	---	---	---	---	---
La Ladysmith	75	40	60	30	3.5	5.0
Ma Morrill	85	42	85	35	4.8	6.5
Mb Morrill	80	38	80	30	3.5	6.0
Mc Morrill	70	34	70	25	3.0	5.5
Me Muir	90	48	95	40	5.0	6.5
Na Nodaway	90	44	95	35	5.0	6.5
Oa Olmitz	85	44	90	35	4.5	6.0
Ob Ortello	60	28	60	20	2.5	5.0
Pa Pawnee	70	36	65	30	3.0	5.5
Pb Pawnee	65	32	60	25	2.5	5.0
Pc Pawnee	55	28	55	20	2.5	4.0
Pd** Pits	---	---	---	---	---	---
Sa Shelby	75	38	75	30	4.0	5.5
Sb Steinauer	---	---	---	---	---	---
Sc. Steinauer	65	28	55	20	2.5	4.5
Shelby	65	28	55	20	2.5	4.5
Ta Tully	70	38	60	30	3.5	5.5

See footnotes at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Grain sorghum	Winter wheat	Corn	Soybeans	Alfalfa hay	Smooth bromegrass
	Bu	Bu	Bu	Bu	Ton	AUM*
Tb: Tully	60	34	50	25	3.0	4.5
Wa: Wabash	75	36	60	30	3.0	5.0
Wb: Wymore	75	38	70	30	3.5	5.5
Wc: Wymore	60	32	60	25	3.0	4.5

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for a period of 30 days.

** See map unit description for the composition and behavior of the map unit.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

[Only the soils that support rangeland vegetation are listed]

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Ea: Eudora	Loamy Lowland	Favorable	10,000	Big bluestem	35
		Normal	8,000	Indiangrass	15
		Unfavorable	6,000	Eastern gamagrass	10
				Prairie cordgrass	10
				Little bluestem	5
				Switchgrass	5
Ga: Geary	Loamy Upland	Favorable	6,000	Big bluestem	25
		Normal	4,000	Little bluestem	20
		Unfavorable	3,000	Switchgrass	10
				Indiangrass	10
				Tall dropseed	5
				Sideoats grama	5
Ka, Kb: Kennebec	Loamy Lowland	Favorable	10,000	Big bluestem	40
		Normal	8,000	Indiangrass	10
		Unfavorable	6,000	Switchgrass	10
				Eastern gamagrass	10
				Prairie cordgrass	5
Kc*:					
Kipson	Limy Upland	Favorable	4,500	Little bluestem	25
		Normal	3,500	Big bluestem	20
		Unfavorable	2,000	Sideoats grama	15
				Switchgrass	5
				Indiangrass	5
				Tall dropseed	5
Sogn	Shallow Limy	Favorable	3,500	Sideoats grama	25
		Normal	2,500	Little bluestem	15
		Unfavorable	1,500	Blue grama	10
				Big bluestem	10
				Buffalograss	5
				Smooth sumac	5
La: Ladysmith	Clay Upland	Favorable	5,500	Big bluestem	25
		Normal	4,000	Little bluestem	20
		Unfavorable	2,000	Indiangrass	15
				Switchgrass	15
				Tall dropseed	5
				Sideoats grama	5
Ma, Mb, Mc: Morrill	Loamy Upland	Favorable	6,000	Big bluestem	35
		Normal	5,000	Little bluestem	20
		Unfavorable	4,000	Indiangrass	10
				Switchgrass	5
				Purpletop	5
Me: Muir	Loamy Terrace	Favorable	7,000	Big bluestem	30
		Normal	5,500	Switchgrass	10
		Unfavorable	3,500	Little bluestem	10
				Indiangrass	10
				Western wheatgrass	5
				Sideoats grama	5
				Tall dropseed	5
				Sedge	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Na: Nodaway	Loamy Lowland	Favorable	10,000	Big bluestem	40
		Normal	8,000	Indiangrass	10
		Unfavorable	6,000	Switchgrass	10
				Eastern gamagrass	10
				Prairie cordgrass	5
Oa: Olmitz	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	15
		Unfavorable	4,000	Indiangrass	10
				Switchgrass	10
				Tall dropseed	5
				Sideoats grama	5
Ob: Ortello	Sandy	Favorable	4,000	Sand bluestem	20
		Normal	3,500	Little bluestem	20
		Unfavorable	2,500	Prairie sandreed	10
				Switchgrass	10
				Western wheatgrass	5
				Blue grama	5
				Sedge	5
Pa, Pb, Pc: Pawnee	Loamy Upland	Favorable	5,000	Big bluestem	30
		Normal	3,500	Little bluestem	25
		Unfavorable	2,000	Switchgrass	10
				Sideoats grama	5
				Tall dropseed	5
Sa: Shelby	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	4,500	Little bluestem	15
		Unfavorable	3,000	Indiangrass	10
				Switchgrass	10
				Tall dropseed	5
				Sideoats grama	5
Sb: Steinauer	Limy Upland	Favorable	4,500	Little bluestem	30
		Normal	3,500	Big bluestem	20
		Unfavorable	2,000	Sideoats grama	10
				Indiangrass	5
				Switchgrass	5
				Tall dropseed	5
Sc*:					
Steinauer	Limy Upland	Favorable	4,500	Little bluestem	30
		Normal	3,500	Big bluestem	20
		Unfavorable	2,000	Sideoats grama	10
				Indiangrass	5
				Switchgrass	5
				Tall dropseed	5
Shelby	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	4,500	Little bluestem	15
		Unfavorable	3,000	Indiangrass	10
				Switchgrass	10
				Tall dropseed	5
				Sideoats grama	5
Ta, Tb: Tully	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	15
		Unfavorable	4,000	Switchgrass	10
				Indiangrass	10
				Tall dropseed	5
				Sideoats grama	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production		Characteristic vegetation	Composition
		Kind of year	Dry weight		
			Lb/acre		Pct
Wa-----------------Wabash	Clay Lowland------------------	Favorable	9,000	Switchgrass-------------------	30
		Normal	8,000	Indiangrass-------------------	15
		Unfavorable	6,000	Big bluestem------------------	15
				Eastern gamagrass-------------	10
				Little bluestem---------------	10
				Prairie cordgrass-------------	10
				Eastern cottonwood------------	5
Wb, Wc-------------Wymore	Clay Upland-------------------	Favorable	5,000	Switchgrass-------------------	25
		Normal	3,500	Big bluestem------------------	20
		Unfavorable	2,000	Little bluestem---------------	15
				Tall dropseed-----------------	8
				Indiangrass-------------------	10
				Sideoats grama----------------	5

* See map unit description for the composition and behavior of the map unit.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Management concerns					Potential productivity		Trees to plant
	Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Important trees	Site index	
Ea----------------- Eudora	Slight	Slight	Slight	Slight	Moderate	Eastern cottonwood-- American sycamore--- Common hackberry---- Black walnut-------- Green ash-----------	105 105 --- --- ---	Eastern cottonwood, American sycamore.
Ka, Kb------------- Kennebec	Slight	Slight	Slight	Slight	Moderate	Black walnut-------- Bur oak------------- Common hackberry---- Green ash----------- Eastern cottonwood--	79 63 --- --- ---	Black walnut, bur oak, common hackberry, green ash, eastern cottonwood, American sycamore.
Me----------------- Muir	Slight	Slight	Slight	Slight	Moderate	Black walnut-------- White oak----------- Northern red oak----	73 --- ---	Black walnut, eastern cottonwood, green ash.
Na----------------- Nodaway	Slight	Slight	Slight	Slight	Slight	White oak----------- Black walnut-------- Northern red oak----	65 --- ---	Eastern white pine, eastern cottonwood, green ash, Scotch pine, black walnut.
Wa----------------- Wabash	Slight	Severe	Slight	Moderate	Severe	Pin oak-------------	75	Pin oak, eastern cottonwood.

TABLE 8.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Ea: Eudora	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: frost action.
Ga: Geary	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: low strength.
Ka, Kb: Kennebec	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods, frost action, low strength.
Kc*:					
Kipson	Severe: depth to rock.	Moderate: slope, depth to rock.	Severe: depth to rock.	Severe: slope.	Moderate: slope, depth to rock.
Sogn	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, low strength.
La: Ladysmith	Moderate: too clayey.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.
Ma, Mb: Morrill	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.
Mc: Morrill	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: low strength.
Me: Muir	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength.
Na: Nodaway	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods, frost action, low strength.
Oa: Olmitz	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.
Ob: Ortello	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Moderate: frost action, low strength.
Pa, Pb, Pc: Pawnee	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength, frost action.
Pd*. Pits					

See footnote at end of table.

TABLE 8.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Sa: Shelby	Moderate: slope.	Moderate: slope, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope.	Severe: low strength.
Sb: Steinauer	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, low strength.
Sc*:					
Steinauer	Moderate: slope.	Moderate: slope, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope.	Severe: low strength.
Shelby	Moderate: slope.	Moderate: slope, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope.	Severe: low strength.
Ta, Tb: Tully	Moderate: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Wa: Wabash	Severe: wetness, floods.	Severe: wetness, floods, shrink-swell, low strength.	Severe: wetness, floods, shrink-swell, low strength.	Severe: wetness, floods, shrink-swell, low strength.	Severe: wetness, floods, low strength, shrink-swell.
Wb, Wc: Wymore	Moderate: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, frost action, low strength.

* See map unit description for the composition and behavior of the map unit.

TABLE 9.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ea------------------- Eudora	Moderate: floods.	Severe: floods.	Moderate: floods.	Moderate: floods.	Good.
Ga------------------- Geary	Severe: percs slowly.	Moderate: slope, seepage.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Ka, Kb--------------- Kennebec	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods.	Severe: floods, wetness.	Good.
Kc*: Kipson---------------	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Sogn-----------------	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
La------------------- Ladysmith	Severe: percs slowly.	Slight-----------	Severe: too clayey.	Slight-----------	Poor: too clayey.
Ma, Mb, Mc----------- Morrill	Severe: percs slowly.	Moderate: slope, seepage.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Me------------------- Muir	Moderate: percs slowly, flooding.	Moderate: seepage.	Moderate: floods.	Moderate: floods.	Good.
Na------------------- Nodaway	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Good.
Oa------------------- Olmitz	Moderate: percs slowly.	Moderate: slope, seepage.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Ob------------------- Ortello	Slight-----------	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: too sandy.
Pa, Pb, Pc----------- Pawnee	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight-----------	Poor: too clayey.
Pd*. Pits					
Sa------------------- Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: too clayey, slope.
Sb------------------- Steinauer	Severe: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Severe: slope.	Poor: slope.
Sc*: Steinauer-----------	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: too clayey, slope.

See footnote at end of table.

TABLE 9.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Sc*:					
Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: too clayey, slope.
Ta, Tb Tully	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey.
Wa Wabash	Severe: percs slowly, floods, wetness.	Severe: floods.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: wetness, too clayey.
Wb, Wc Wymore	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.

* See map unit description for the composition and behavior of the map unit.

TABLE 10.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," and "unsuited." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ea-----Eudora	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Ga-----Geary	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Ka, Kb-----Kennebec	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Kc*:				
Kipson-----	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer, area reclaim.
Sogn-----	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: area reclaim.
La-----Ladysmith	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, too clayey.
Ma, Mb-----Morrill	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Mc-----Morrill	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, thin layer.
Me-----Muir	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Na-----Nodaway	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Oa-----Olmitz	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Ob-----Ortello	Good-----	Fair: excess fines.	Unsuited: excess fines.	Good.
Pa, Pb, Pc-----Pawnee	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, thin layer.
Pd*. Pits				
Sa-----Shelby	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, slope.
Sb-----Steinauer	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.

See footnote at end of table.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Sc*:				
Steinauer	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, slope.
Shelby	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, slope.
Ta, Tb Tully	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Wa Wabash	Poor: wetness, shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
Wb, Wc Wymore	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer.

* See map unit description for the composition and behavior of the map unit.

TABLE 11.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Ea Eudora	Seepage	Piping	Not needed	Favorable	Not needed	Favorable.
Ga Geary	Seepage	Favorable	Not needed	Favorable	Erodes easily	Favorable.
Ka, Kb Kennebec	Seepage	Piping	Floods, frost action.	Floods	Not needed	Favorable.
Kc*:						
Kipson	Slope, depth to rock.	Thin layer	Not needed	Droughty, rooting depth, slope.	Slope, depth to rock.	Slope, droughty, depth to rock, rooting depth.
Sogn	Slope, depth to rock.	Thin layer	Not needed	Droughty, rooting depth, slope.	Depth to rock	Droughty, rooting depth, depth to rock.
La Ladysmith	Favorable	Hard to pack	Percs slowly	Percs slowly, erodes easily.	Not needed	Percs slowly, erodes easily.
Ma, Mb Morrill	Seepage	Favorable	Not needed	Favorable	Favorable	Favorable.
Mc Morrill	Seepage	Favorable	Not needed	Slope	Favorable	Favorable.
Me Muir	Seepage	Favorable	Not needed	Favorable	Not needed	Favorable.
Na Nodaway	Seepage	Favorable	Floods	Floods	Not needed	Favorable.
Oa Olmitz	Seepage	Favorable	Not needed	Favorable	Favorable	Favorable.
Ob Ortello	Slope, seepage.	Seepage, piping.	Not needed	Soil blowing, slope.	Soil blowing	Favorable.
Pa, Pb Pawnee	Favorable	Hard to pack	Not needed	Percs slowly, erodes easily.	Percs slowly	Percs slowly, erodes easily.
Pc Pawnee	Favorable	Hard to pack	Not needed	Percs slowly, erodes easily, slow intake.	Percs slowly	Percs slowly, erodes easily.
Pd*. Pits						
Sa Shelby	Slope	Favorable	Not needed	Slope	Favorable	Slope.
Sb Steinauer	Slope, seepage.	Favorable	Not needed	Slope	Slope	Slope.
Sc*:						
Steinauer	Slope, seepage.	Favorable	Not needed	Slope	Slope	Slope.

See footnote at end of table.

TABLE 11.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Sc*:						
Shelby	Slope	Favorable	Not needed	Slope	Slope	Slope.
Ta, Tb: Tully	Favorable	Hard to pack	Not needed	Percs slowly, erodes easily.	Percs slowly	Erodes easily, percs slowly.
Wa: Wabash	Favorable	Wetness, hard to pack.	Floods, percs slowly.	Floods, wetness, percs slowly.	Not needed	Percs slowly, wetness.
Wb, Wc: Wymore	Favorable	Hard to pack	Not needed	Percs slowly, erodes easily.	Percs slowly	Percs slowly, erodes easily.

* See map unit description for the composition and behavior of the map unit.

TABLE 12.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ea: Eudora	Severe: floods.	Slight	Slight	Slight.
Ga: Geary	Slight	Slight	Moderate: slope.	Slight.
Ka, Kb: Kennebec	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.
Kc*:				
Kipson	Severe: depth to rock	Moderate: slope.	Severe: depth to rock, slope.	Moderate: slope.
Sogn	Severe: depth to rock.	Moderate: slope.	Severe: depth to rock, slope.	Slight.
La: Ladysmith	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Ma, Mb: Morrill	Slight	Slight	Moderate: slope.	Slight.
Mc: Morrill	Moderate: too clayey.	Moderate: too clayey.	Moderate: slope, too clayey.	Moderate: too clayey.
Me: Muir	Severe: floods.	Slight	Slight	Slight.
Na: Nodaway	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.
Oa: Olmitz	Slight	Slight	Moderate: slope.	Slight.
Ob: Ortello	Slight	Slight	Severe: slope.	Slight.
Pa: Pawnee	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Moderate: percs slowly, too clayey.	Moderate: too clayey.
Pb: Pawnee	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Moderate: percs slowly.	Moderate: too clayey.
Pc: Pawnee	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.
Pd*. Pits				

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Sa: Shelby	Moderate: slope, percs slowly, too clayey.	Moderate: too clayey, slope.	Severe: slope.	Moderate: too clayey.
Sb: Steinauer	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too clayey, slope.
Sc*:				
Steinauer	Moderate: percs slowly, slope, too clayey.	Moderate: slope, too clayey.	Severe: slope.	Moderate: too clayey.
Shelby	Moderate: slope, percs slowly, too clayey.	Moderate: too clayey, slope.	Severe: slope.	Moderate: too clayey.
Ta, Tb: Tully	Moderate: too clayey.	Slight	Moderate: too clayey, slope.	Slight.
Wa: Wabash	Severe: floods, wetness, percs slowly.	Severe: wetness.	Severe: wetness, percs slowly.	Moderate: wetness, too clayey.
Wb, Wc: Wymore	Moderate: too clayey, percs slowly.	Moderate: too clayey.	Moderate: slope, too clayey, percs slowly.	Moderate: too clayey.

* See map unit description for the composition and behavior of the map unit.

TABLE 13.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Ea: Eudora	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	---
Ga: Geary	Fair	Good	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Ka, Kb: Kennebec	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	---
Kc*:												
Kipson	Poor	Fair	Fair	---	---	Poor	Very poor.	Very poor.	Fair	---	Very poor.	Poor.
Sogn	Very poor.	Very poor.	Poor	---	---	Poor	Very poor.	Very poor.	Very poor.	---	Very poor.	Poor.
La: Ladysmith	Fair	Good	Good	---	---	Good	Poor	Fair	Good	---	Poor	Good.
Ma, Mb: Morrill	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Fair	Very poor.	Good.
Mc: Morrill	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	---	Very poor.	Good.
Me: Muir	Good	Good	Good	---	---	Good	Poor	Very poor.	Good	---	Very poor.	Good.
Na: Nodaway	Good	Good	Good	Good	Fair	Good	Fair	Poor	Good	Good	Poor	---
Oa: Olmitz	Good	Good	Fair	Good	Good	Good	Poor	Poor	Good	Good	Poor	---
Ob: Ortello	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	---	Very poor.	Good.
Pa, Pb, Pc: Pawnee	Fair	Good	Good	Fair	Fair	Fair	Very poor.	Good	Good	---	Poor	Fair.
Pd*. Pits												
Sa: Shelby	Fair	Good	Fair	Good	Good	Good	Poor	Poor	Fair	---	Poor	---
Sb: Steinauer	Poor	Fair	Good	Fair	Good	Good	Very poor.	Very poor.	Fair	---	Very poor.	Good.
Sc*:												
Steinauer	Poor	Fair	Good	Fair	Good	Good	Very poor.	Very poor.	Fair	---	Very poor.	Good.
Shelby	Fair	Good	Fair	Good	Good	Good	Poor	Poor	Fair	---	Poor	---
Ta, Tb: Tully	Fair	Good	Good	Fair	Fair	Fair	Poor	Poor	Good	---	Poor	Fair.
Wa: Wabash	Poor	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good	---
Wb, Wc: Wymore	Fair	Good	Fair	Good	Good	Fair	Very poor.	Very poor.	Fair	Good	Very poor.	Fair.

* See map unit description for the composition and behavior of the map unit.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Ea: Eudora	0-14	Silt loam	ML, CL, CL-ML	A-4	0	100	100	95-100	60-98	20-35	2-10
	14-60	Silt loam, very fine sandy loam.	ML, CL, CL-ML	A-4	0	100	100	95-100	60-98	10-25	NP-10
Ga: Geary	0-9	Silt loam	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	80-98	25-40	2-15
	9-46	Silty clay loam, clay loam.	CL	A-7, A-6	0	100	100	96-100	85-98	35-50	15-25
	46-60	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	96-100	85-98	30-45	11-20
Ka, Kb: Kennebec	0-47	Silt loam	CL, ML	A-6, A-7	0	100	100	95-100	90-100	30-50	10-20
	47-60	Silt loam, silty clay loam.	CL, ML	A-6, A-7	0	100	100	95-100	90-100	30-50	10-20
Kc*:											
Kipson	0-12	Silty clay loam	CL-ML, CL	A-4, A-6	0-25	70-100	70-95	65-95	60-95	25-40	5-20
	12-19	Shaly silt loam, shaly silty clay loam, shaly loam.	CL-ML, CL	A-6, A-4	0-25	70-100	70-95	65-95	60-95	25-40	5-20
	19	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Sogn	0-14	Silty clay loam	CL	A-6, A-7	0-10	85-100	85-100	85-100	80-95	25-45	11-23
	14	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
La: Ladysmith	0-9	Silty clay loam	CL	A-6	0	100	100	95-100	90-100	30-40	10-20
	9-32	Silty clay, clay	CH	A-7-6	0	100	100	95-100	90-100	50-65	30-45
	32-60	Silty clay, silty clay loam, clay.	CL, CH	A-7-6	0	100	100	95-100	90-100	40-55	15-30
Ma, Mb: Morrill	0-12	Loam	ML, CL, CL-ML	A-4, A-6	0	100	100	94-100	50-85	20-35	2-15
	12-43	Clay loam, sandy clay loam.	CL	A-4, A-6, A-7	0	100	100	90-100	55-85	30-45	8-20
	43-60	Sandy clay loam, clay loam, sandy loam.	CL, ML, CL-ML, SM	A-4, A-6	0	100	100	90-100	55-85	25-40	2-15
Mc: Morrill	0-8	Clay loam	ML, CL, CL-ML	A-4, A-6	0	100	100	94-100	50-85	20-35	2-15
	8-32	Clay loam, sandy clay loam.	CL	A-4, A-6, A-7	0	100	100	90-100	55-85	30-45	8-20
	32-60	Sandy clay loam, clay loam, sandy loam.	CL, ML, CL-ML, SM	A-4, A-6	0	100	100	90-100	55-85	25-40	2-15
Me: Muir	0-45	Silt loam	CL	A-4, A-6	0	100	100	95-100	85-100	25-40	8-20
	45-60	Silt loam, silty clay loam, loam.	CL	A-4, A-6	0	100	100	95-100	85-100	25-40	8-20

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Na----------------- Nodaway	0-60	Silt loam-------	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
Oa----------------- Olmitz	0-21	Loam------------	CL	A-6	0	100	90-100	85-95	60-80	30-40	11-20
	21-60	Clay loam-------	CL	A-6, A-7	0	100	90-100	85-95	60-80	35-45	15-25
Ob----------------- Ortello	0-20	Sandy loam------	SM, ML	A-4	0	100	100	70-85	40-55	<20	NP
	20-36	Fine sandy loam, sandy loam.	SM, ML	A-4	0	100	100	70-85	40-55	<20	NP
	36-60	Fine sand, loamy fine sand.	SP-SM, SM	A-3, A-2	0	100	100	50-75	5-35	---	NP
Pa, Pb------------- Pawnee	0-13	Clay loam-------	CL	A-6	0	95-100	95-100	85-100	70-90	30-40	10-20
	13-36	Clay------------	CH	A-7	0	95-100	95-100	85-100	70-85	50-70	25-45
	36-60	Clay loam, sandy clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	80-100	70-90	35-55	20-40
Pc----------------- Pawnee	0-6	Clay------------	CL, CH	A-6, A-7	0	95-100	95-100	85-100	70-90	40-60	20-40
	6-26	Clay------------	CH	A-7	0	95-100	95-100	85-100	70-85	50-70	25-45
	26-60	Clay loam, sandy clay loam.	CL, CH	A-6, A-7	0	95-100	95-100	80-100	70-90	35-55	20-40
Pd*. Pits											
Sa----------------- Shelby	0-17	Clay loam-------	CL	A-6	0	90-100	85-98	75-90	55-70	30-40	11-20
	17-48	Clay loam-------	CL	A-6, A-7	0	90-100	85-98	75-90	55-70	30-40	15-25
	48-60	Clay loam-------	CL	A-6, A-7	0	90-100	85-98	75-90	55-70	30-40	15-25
Sb----------------- Steinauer	0-5	Clay loam-------	CL	A-6, A-7	0-5	95-100	95-100	90-100	70-90	30-50	15-25
	5-18	Clay loam-------	CL, CH	A-6, A-7	0-5	95-100	95-100	90-100	70-90	30-55	15-30
	18-60	Loam, clay loam	CL	A-6	0-5	95-100	95-100	90-100	60-75	20-40	10-20
Sc*:											
Steinauer----------	0-5	Clay loam-------	CL	A-6, A-7	0-5	95-100	95-100	90-100	70-90	30-50	15-25
	5-18	Clay loam-------	CL, CH	A-6, A-7	0-5	95-100	95-100	90-100	70-90	30-55	15-30
	18-60	Loam, clay loam	CL	A-6	0-5	95-100	95-100	90-100	60-75	20-40	10-20
Shelby-------------	0-17	Clay loam-------	CL	A-6	0	90-100	85-98	75-90	55-70	30-40	11-20
	17-48	Clay loam-------	CL	A-6, A-7	0	90-100	85-98	75-90	55-70	30-40	15-25
	48-60	Clay loam-------	CL	A-6, A-7	0	90-100	85-98	75-90	55-70	30-40	15-25
Ta, Tb------------- Tully	0-19	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	85-95	35-50	11-22
	19-60	Silty clay, clay, cherty silty clay.	CH, CL	A-7	0	85-100	85-100	85-100	85-95	40-60	20-35
Wa----------------- Wabash	0-13	Silty clay loam	CL, CH	A-6, A-7	0	100	100	100	95-100	30-55	12-35
	13-60	Silty clay, clay	CH	A-7	0	100	100	100	95-100	52-78	30-55
Wb, Wc------------- Wymore	0-6	Silty clay loam	CL, CH, ML, MH	A-6, A-7	0	100	100	95-100	95-100	38-55	15-25
	6-26	Silty clay------	CH	A-7	0	100	100	95-100	95-100	55-65	30-40
	26-60	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	85-100	35-55	20-35

* See map unit description for the composition and behavior of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm				
Ea----------------	0-14	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low--------	0.32	5	6
Eudora	14-60	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low--------	0.43		
Ga----------------	0-9	0.6-2.0	0.18-0.24	5.6-6.5	<2	Low--------	0.32	5	6
Geary	9-46	0.2-2.0	0.17-0.20	6.1-7.8	<2	Moderate	0.43		
	46-60	0.6-2.0	0.15-0.19	6.6-7.8	<2	Moderate	0.43		
Ka, Kb------------	0-47	0.6-2.0	0.22-0.24	5.6-6.5	<2	Moderate	0.32	5	6
Kennebec	47-60	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.43		
Kc*:									
Kipson------------	0-12	0.6-2.0	0.18-0.24	7.9-8.4	<2	Low--------	0.37	2	4L
	12-19	0.6-2.0	0.15-0.20	7.9-8.4	<2	Moderate	0.37		
	19	---	---	---	---	-----------	---		
Sogn--------------	0-14	0.6-2.0	0.17-0.22	6.1-8.4	<2	Moderate	0.28	1	4L
	14	---	---	---	---	-----------	---		
La----------------	0-9	0.2-2.0	0.21-0.23	5.6-7.3	<2	Moderate	0.37	4	7
Ladysmith	9-32	<0.06	0.10-0.15	5.6-7.8	<2	High-------	0.37		
	32-60	0.06-0.6	0.10-0.19	7.4-8.4	<2	Moderate	0.37		
Ma, Mb------------	0-12	0.6-2.0	0.14-0.21	5.1-6.5	<2	Low--------	0.28	5	6
Morrill	12-43	0.2-0.6	0.15-0.19	5.1-6.5	<2	Moderate	0.28		
	43-60	0.2-2.0	0.15-0.18	5.1-7.3	<2	Low--------	0.37		
Mc----------------	0-8	0.6-2.0	0.14-0.21	5.1-6.5	<2	Low--------	0.28	5	6
Morrill	8-32	0.2-0.6	0.15-0.19	5.1-6.5	<2	Moderate	0.28		
	32-60	0.2-2.0	0.15-0.18	5.1-7.3	<2	Low--------	0.37		
Me----------------	0-45	0.6-2.0	0.20-0.23	5.6-7.8	<2	Low	0.32	5	6
Muir	45-60	0.6-2.0	0.18-0.22	5.6-7.8	<2	Low	0.43		
Na----------------	0-60	0.6-2.0	0.20-0.23	6.1-7.3	<2	Moderate	0.37	5	6
Nodaway									
Oa----------------	0-21	0.6-2.0	0.19-0.21	5.6-6.5	<2	Moderate	0.28	5	6
Olmitz	21-60	0.6-2.0	0.15-0.17	5.1-6.5	<2	Moderate	0.28		
Ob----------------	0-20	2.0-6.0	0.16-0.18	6.1-6.5	<2	Low--------	0.20	4	3
Ortello	20-36	2.0-6.0	0.15-0.17	6.6-7.3	<2	Low--------	0.20		
	36-60	6.0-20	0.05-0.10	6.6-7.8	<2	Low--------	0.20		
Pa, Pb------------	0-13	0.2-0.6	0.17-0.19	5.6-6.5	<2	Moderate	0.37	4	6
Pawnee	13-36	0.06-0.2	0.09-0.11	6.1-8.4	<2	High-------	0.37		
	36-60	0.2-0.6	0.14-0.16	7.9-8.4	<2	High-------	0.37		
Pc----------------	0-6	0.06-0.2	0.13-0.15	5.6-6.5	<2	High	0.37	4	4
Pawnee	6-26	0.06-0.2	0.09-0.11	6.1-8.4	<2	High	0.37		
	26-60	0.2-0.6	0.14-0.16	7.9-8.4	<2	High	0.37		
Pd*.									
Pits									
Sa----------------	0-17	0.6-2.0	0.20-0.22	5.6-6.5	<2	Moderate	0.28	5	6
Shelby	17-48	0.2-0.6	0.16-0.18	5.6-7.8	<2	Moderate	0.28		
	48-60	0.2-0.6	0.16-0.18	6.6-8.4	<2	Moderate	0.37		
Sb----------------	0-5	0.2-0.6	0.16-0.17	7.4-8.4	<2	Moderate	0.32	5	4L
Steinauer	5-18	0.2-0.6	0.14-0.17	7.9-8.4	<2	Moderate	0.32		
	18-60	0.2-2.0	0.13-0.16	7.9-8.4	<2	Moderate	0.32		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm				
Sc*:									
Steinauer--------	0-5	0.2-0.6	0.16-0.17	7.4-8.4	<2	Moderate	0.32	4	4L
	5-18	0.2-0.6	0.14-0.17	7.9-8.4	<2	Moderate	0.32		
	18-60	0.2-2.0	0.13-0.16	7.9-8.4	<2	Moderate	0.32		
Shelby-----------	0-17	0.6-2.0	0.20-0.22	5.6-6.5	<2	Moderate	0.28	5	6
	17-48	0.2-0.6	0.16-0.18	5.6-7.8	<2	Moderate	0.28		
	48-60	0.2-0.6	0.16-0.18	6.6-8.4	<2	Moderate	0.37		
Ta, Tb------------ Tully	0-19	0.2-2.0	0.18-0.23	5.6-7.3	<2	Moderate	0.37	4	7
	19-60	0.06-0.2	0.10-0.15	6.1-8.4	<2	High------	0.37		
Wa---------------- Wabash	0-13	0.06-0.2	0.21-0.24	5.6-7.3	<2	High------	0.28	5	4
	13-60	<0.06	0.08-0.12	5.6-7.8	<2	High------	0.28		
Wb, Wc------------ Wymore	0-6	0.2-0.6	0.21-0.23	5.6-6.5	<2	Moderate	0.37	4	7
	6-26	0.06-0.2	0.11-0.14	5.6-7.3	<2	High------	0.37		
	26-60	0.2-0.6	0.18-0.20	6.6-7.3	<2	High------	0.37		

* See map unit description for the composition and behavior of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

[The definitions of "flooding" and "water table" in the text explain terms such as "rare," "brief," "apparent," and "perched." The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
Ea----------------- Eudora	B	Rare to occasional	Very brief	Mar-Jun	>6.0	---	---	>60	---	High-----	Low------	Low.
Ga----------------- Geary	B	None---------	---	---	>6.0	---	---	>60	---	Low------	Low------	Low.
Ka, Kb------------ Kennebec	B	Frequent----	Brief-----	Feb-Nov	2.5-5.0	Apparent	Nov-May	>60	---	High-----	Moderate	Low.
Kc*:												
Kipson------------	D	None---------	---	---	>6.0	---	---	7-20	Rippable	Moderate	Low------	Low.
Sogn--------------	D	None---------	---	---	>6.0	---	---	4-20	Hard	Moderate	Low------	Low.
La----------------- Ladysmith	D	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
Ma, Mb, Mc-------- Morrill	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Me----------------- Muir	B	Rare---------	---	---	>6.0	---	---	>60	---	Moderate	Low	Low.
Na----------------- Nodaway	B	Frequent----	Brief-----	Feb-Nov	>6.0	---	---	>60	---	High-----	Moderate	Low.
Oa----------------- Olmitz	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Ob----------------- Ortello	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
Pa, Pb, Pc-------- Pawnee	D	None---------	---	---	>6.0	---	---	>60	---	High-----	High-----	Low.
Pd*. Pits												
Sa----------------- Shelby	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Sb----------------- Steinauer	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
Sc*:												
Steinauer---------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
Sc*:												
Shelby----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Ta, Tb------------ Tully	C	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
Wa---------------- Wabash	D	Frequent----	Brief to long.	Nov-May	0-1.0	Perched	Nov-May	>60	---	Moderate	High-----	Moderate.
Wb, Wc------------ Wymore	D	None---------	---	---	>6.0	---	---	>60	---	High-----	High-----	Moderate.

* See map unit description for the composition and behavior of the map unit.

TABLE 17.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Eudora	Coarse-silty, mixed, mesic Fluventic Hapludolls
Geary	Fine-silty, mixed, mesic Udic Argiustolls
Kennebec	Fine-silty, mixed, mesic Cumulic Hapludolls
Kipson	Loamy, mixed, mesic, shallow Udorthentic Haplustolls
Ladysmith	Fine, montmorillonitic, mesic Pachic Argiustolls
Morrill	Fine-loamy, mixed, mesic Typic Argiudolls
Muir	Fine-silty, mixed, mesic Cumulic Haplustolls
Nodaway	Fine-silty, mixed, nonacid, mesic Mollic Udifluvents
Olmitz	Fine-loamy, mixed, mesic Cumulic Hapludolls
*Ortello	Coarse-loamy, mixed, mesic Udic Haplustolls
Pawnee	Fine, montmorillonitic, mesic Aquic Argiudolls
Shelby	Fine-loamy, mixed, mesic Typic Argiudolls
Sogn	Loamy, mixed, mesic Lithic Haplustolls
Steinauer	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Tully	Fine, mixed, mesic Pachic Argiustolls
Wabash	Fine, montmorillonitic, mesic Vertic Haplaquolls
Wymore	Fine, montmorillonitic, mesic Aquic Argiudolls

* The Ortello soils in this county are taxadjuncts to the Ortello series because the mollic epipedon is more than 20 inches thick. This difference does not affect the use and management of the soils.

☆U.S. GOVERNMENT PRINTING OFFICE: 1980-298-864/20

NRCS Accessibility Statement

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
KANSAS AGRICULTURAL EXPERIMENT STATION

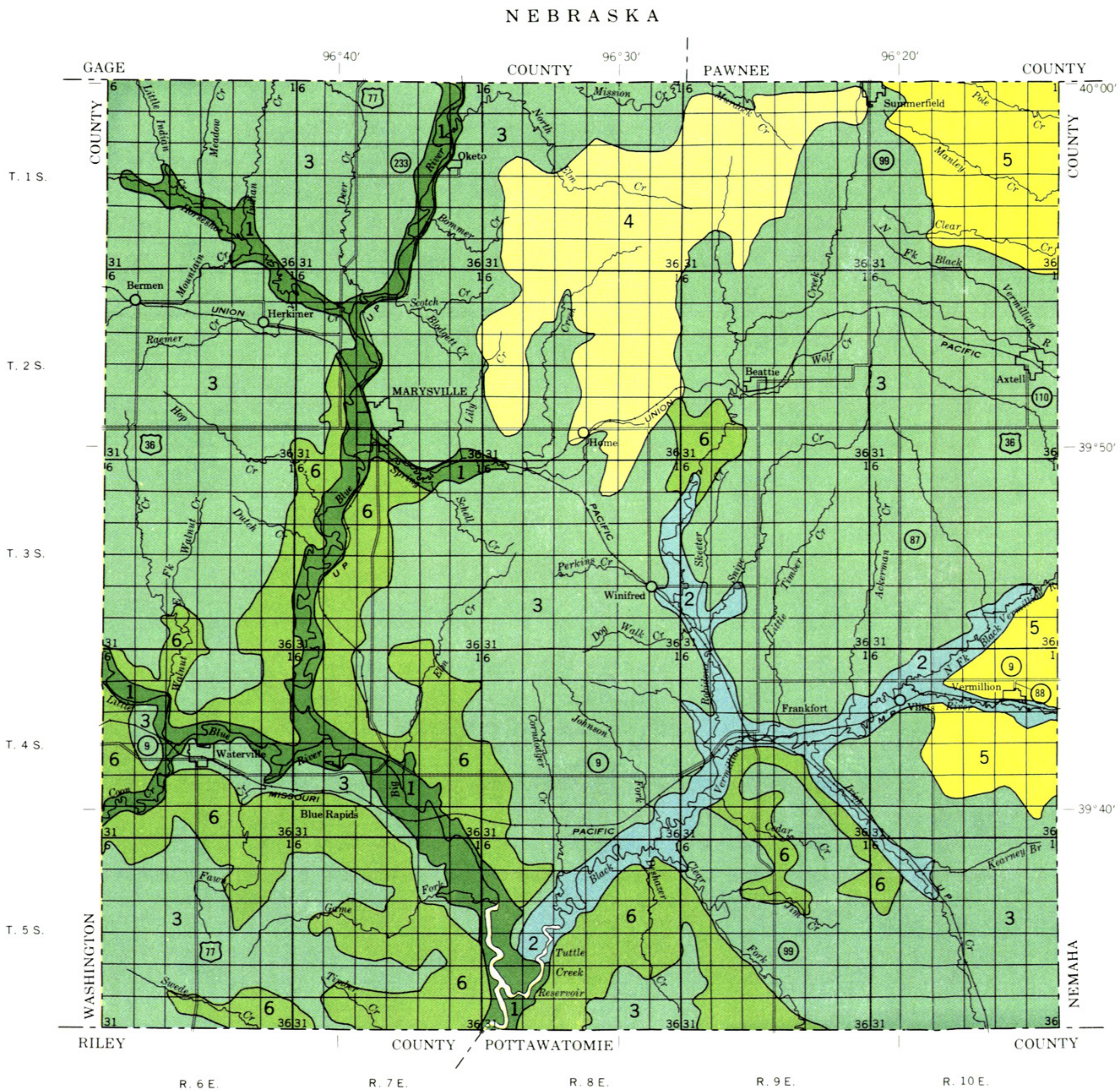
GENERAL SOIL MAP

MARSHALL COUNTY, KANSAS

Scale 1: 253,440

1 0 1 2 3 4 Miles

1 0 1 2 3 4 5 6 Kilometers



SOIL LEGEND

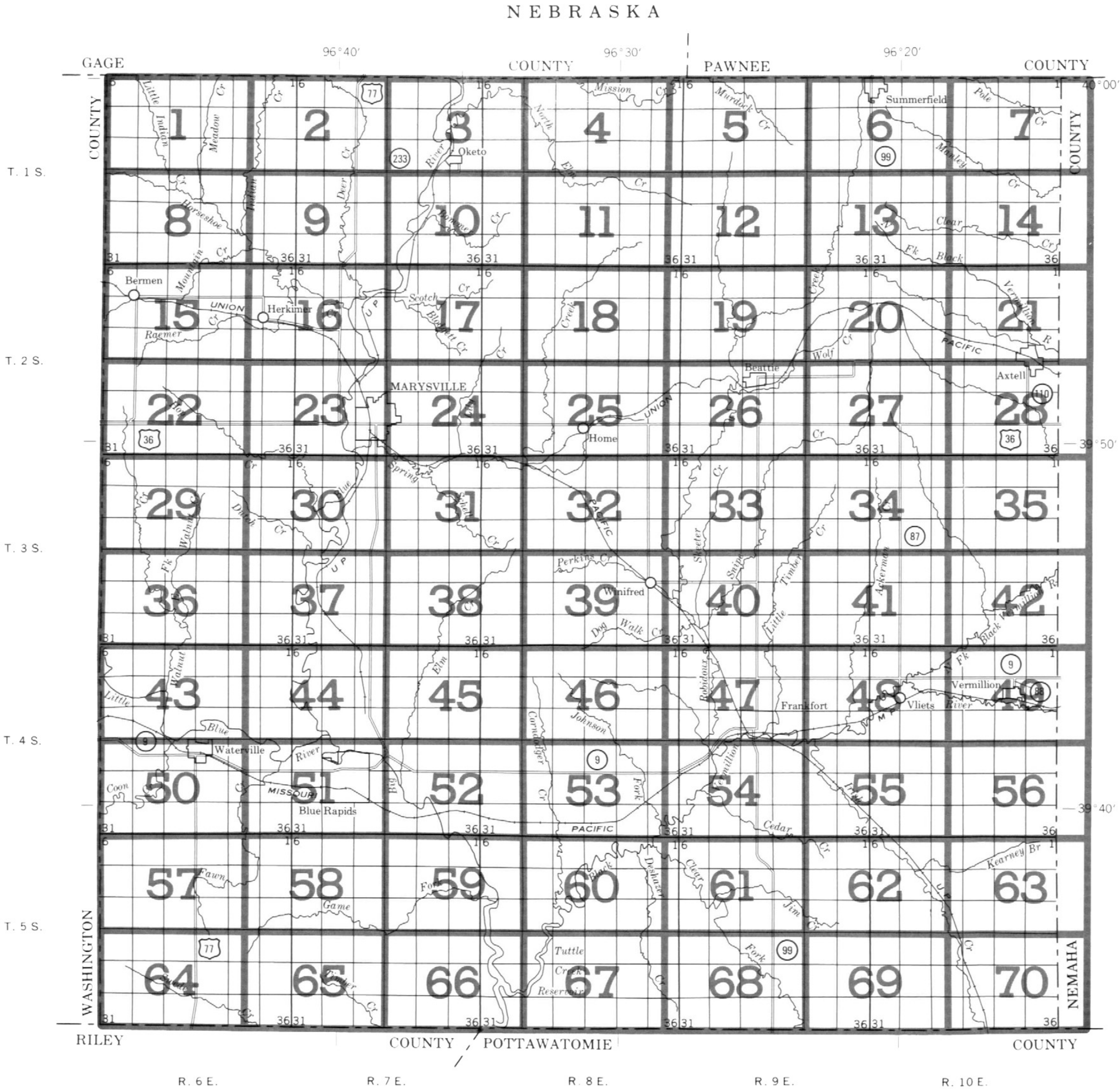
1	Muir-Eudora-Nodaway: Deep, nearly level, well drained and moderately well drained soils on flood plains and terraces
2	Wabash-Nodaway-Muir: Deep, nearly level, very poorly drained, moderately well drained, and well drained soils on flood plains and terraces
3	Wymore-Pawnee: Deep, gently sloping and moderately sloping, moderately well drained soils on uplands
4	Wymore-Ladysmith: Deep, gently sloping and nearly level, moderately well drained and somewhat poorly drained soils on uplands
5	Pawnee-Shelby-Steinauer: Deep, gently sloping to moderately steep, moderately well drained and well drained soils on uplands
6	Kipson-Tully: Shallow and deep, moderately steep and moderately sloping, somewhat excessively drained and well drained soils on uplands

Compiled 1979

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



INDEX TO MAP SHEETS

MARSHALL COUNTY, KANSAS

Scale 1:253,440

1 0 1 2 3 4 Miles

1 0 1 2 3 4 5 6 Kilometers

Original text from each individual map sheet read:
This map is compiled on 1977 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

SYMBOL	NAME
Ea	Eudora silt loam
Ga	Geary silt loam, 3 to 7 percent slopes
Ka	Kennebec silt loam
Kb	Kennebec silt loam, channeled
Kc	Kipson-Sogn silty clay loams, 5 to 25 percent slopes
La	Ladysmith silty clay loam
Ma	Morrill loam, 1 to 4 percent slopes
Mb	Morrill loam, 4 to 8 percent slopes
Mc	Morrill clay loam, 4 to 8 percent slopes, eroded
Me	Muir silt loam
Na	Nodaway silt loam
Oa	Olmitz loam, 1 to 4 percent slopes
Ob	Ortello sandy loam, 4 to 10 percent slopes
Pa	Pawnee clay loam, 1 to 4 percent slopes
Pb	Pawnee clay loam, 4 to 8 percent slopes
Pc	Pawnee clay, 3 to 8 percent slopes, eroded
Pd	Pits
Sa	Shelby clay loam, 6 to 10 percent slopes
Sb	Steinauer clay loam, 14 to 25 percent slopes
Sc	Steinauer-Shelby clay loams, 10 to 14 percent slopes
Ta	Tully silty clay loam, 3 to 7 percent slopes
Tb	Tully silty clay loam, 3 to 7 percent slopes, eroded
Wa	Wabash silty clay loam
Wb	Wymore silty clay loam, 1 to 4 percent slopes
Wc	Wymore silty clay loam, 3 to 6 percent slopes, eroded

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool — Davis Airstrip; FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate — 79
- Federal — 410
- State — 52
- County, farm or ranch — 378

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small — water; w

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — GAS
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water; w
- Intermittent — int; i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — CeA; FoB2

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

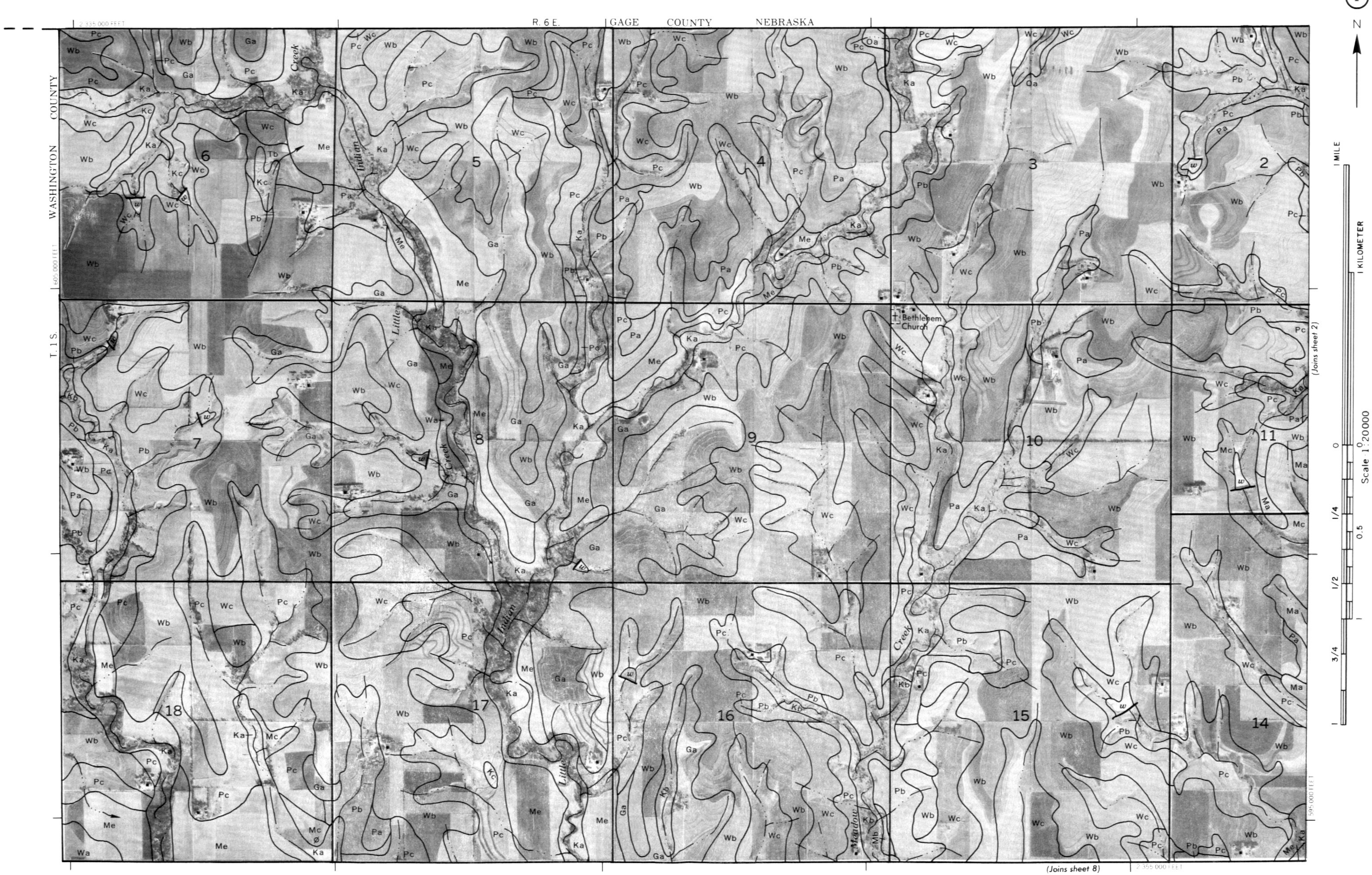
DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown) — S

MISCELLANEOUS

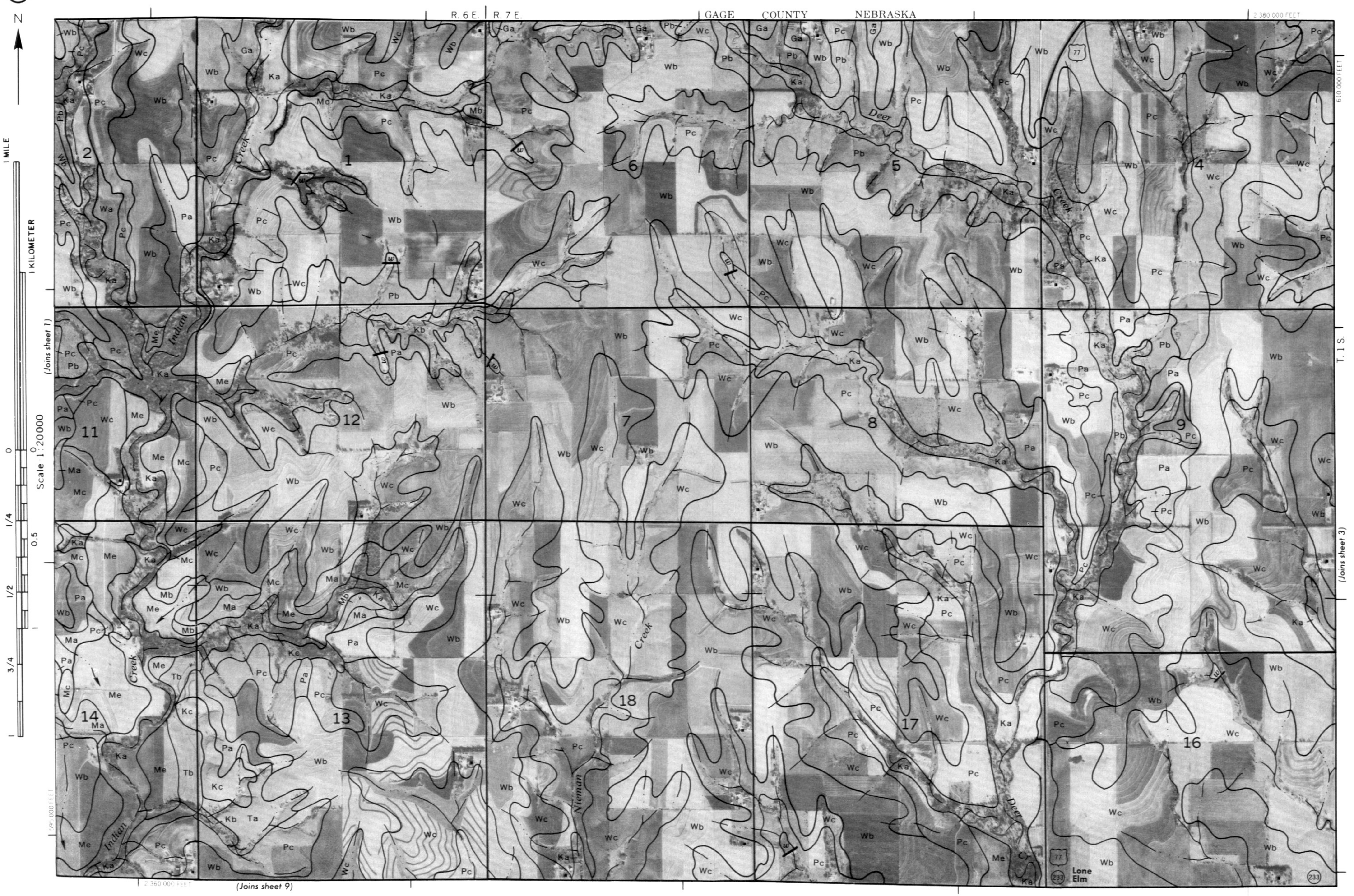
- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot

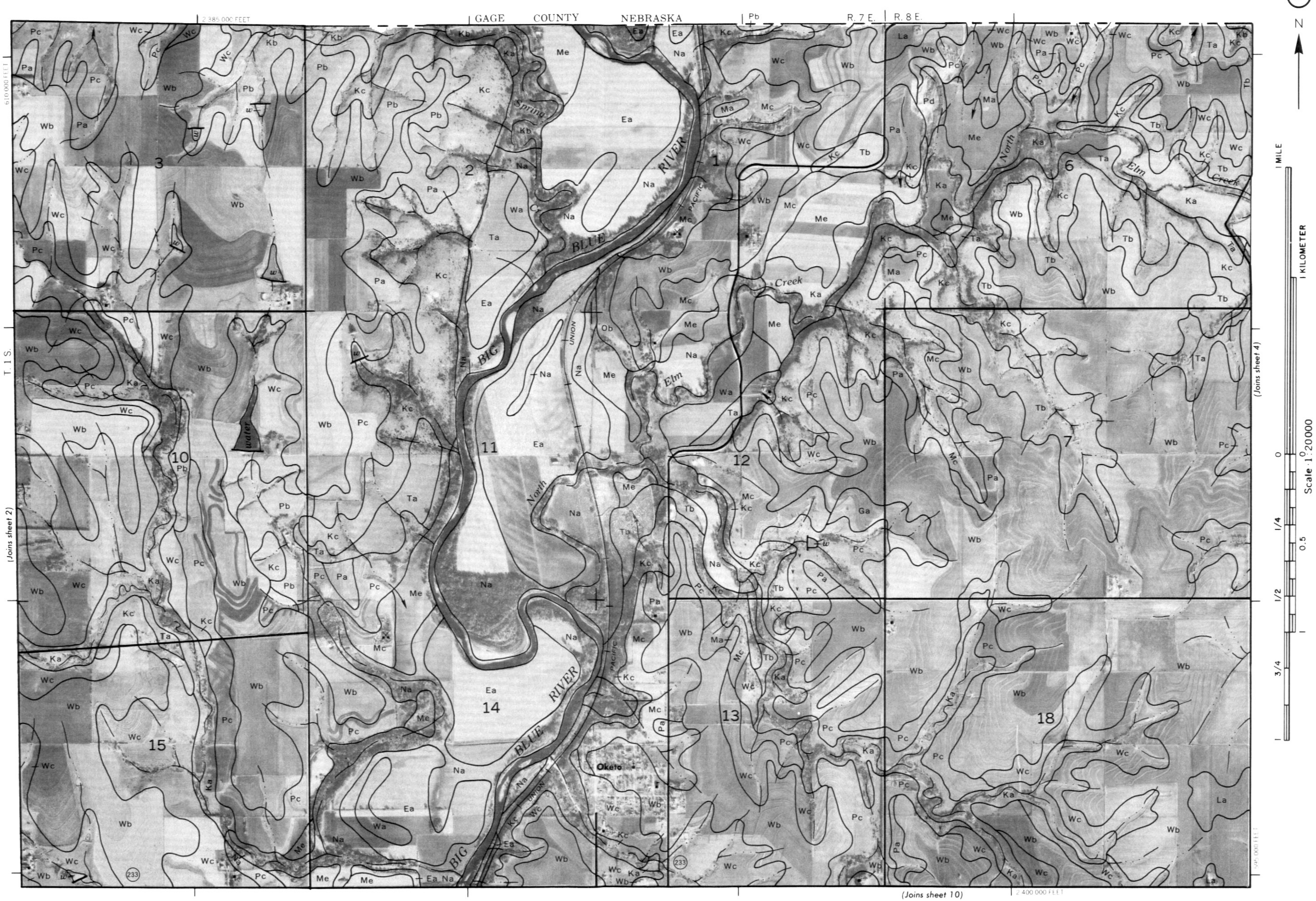
MARSHALL COUNTY, KANSAS — SHEET NUMBER 1

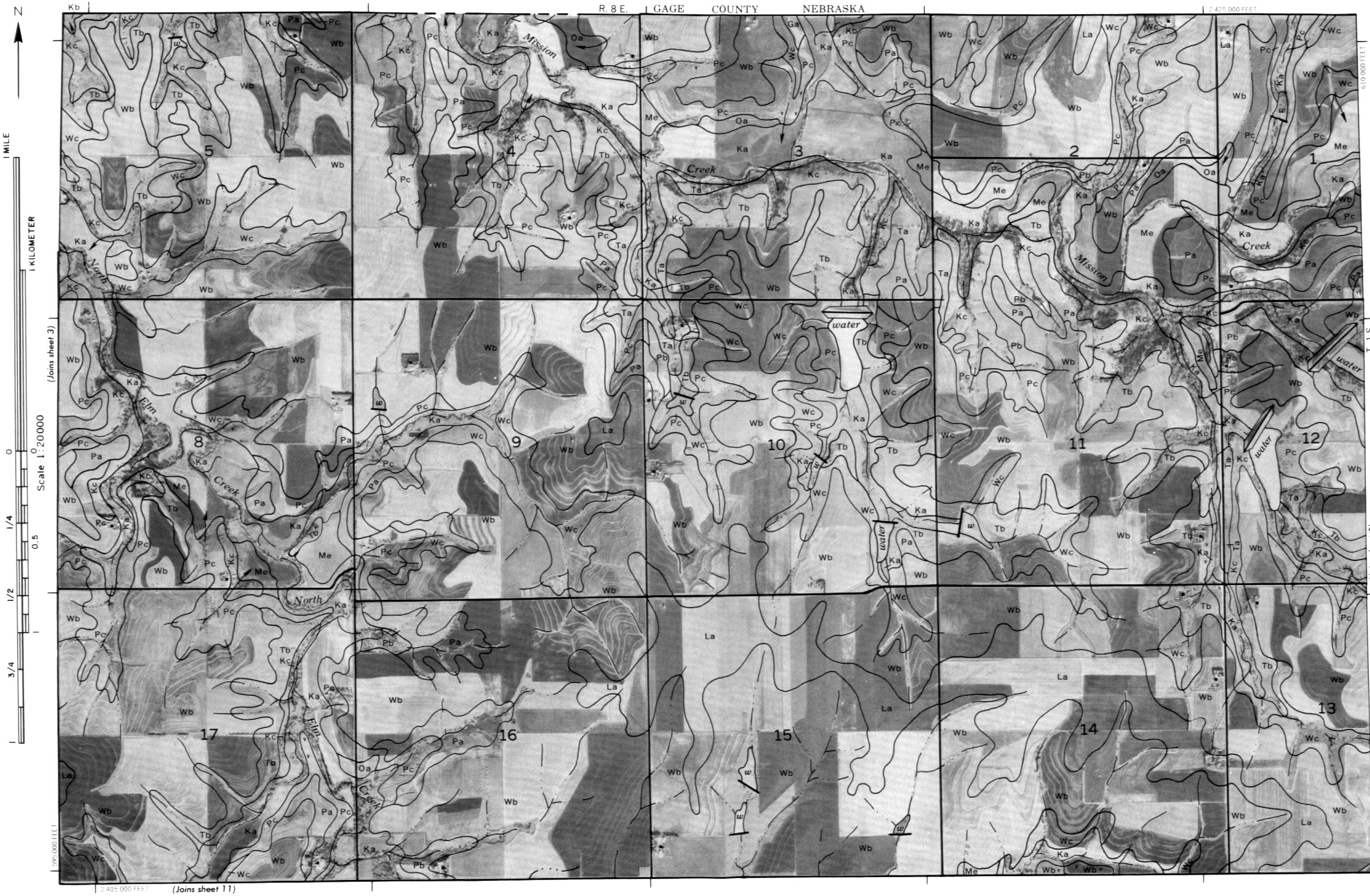


2

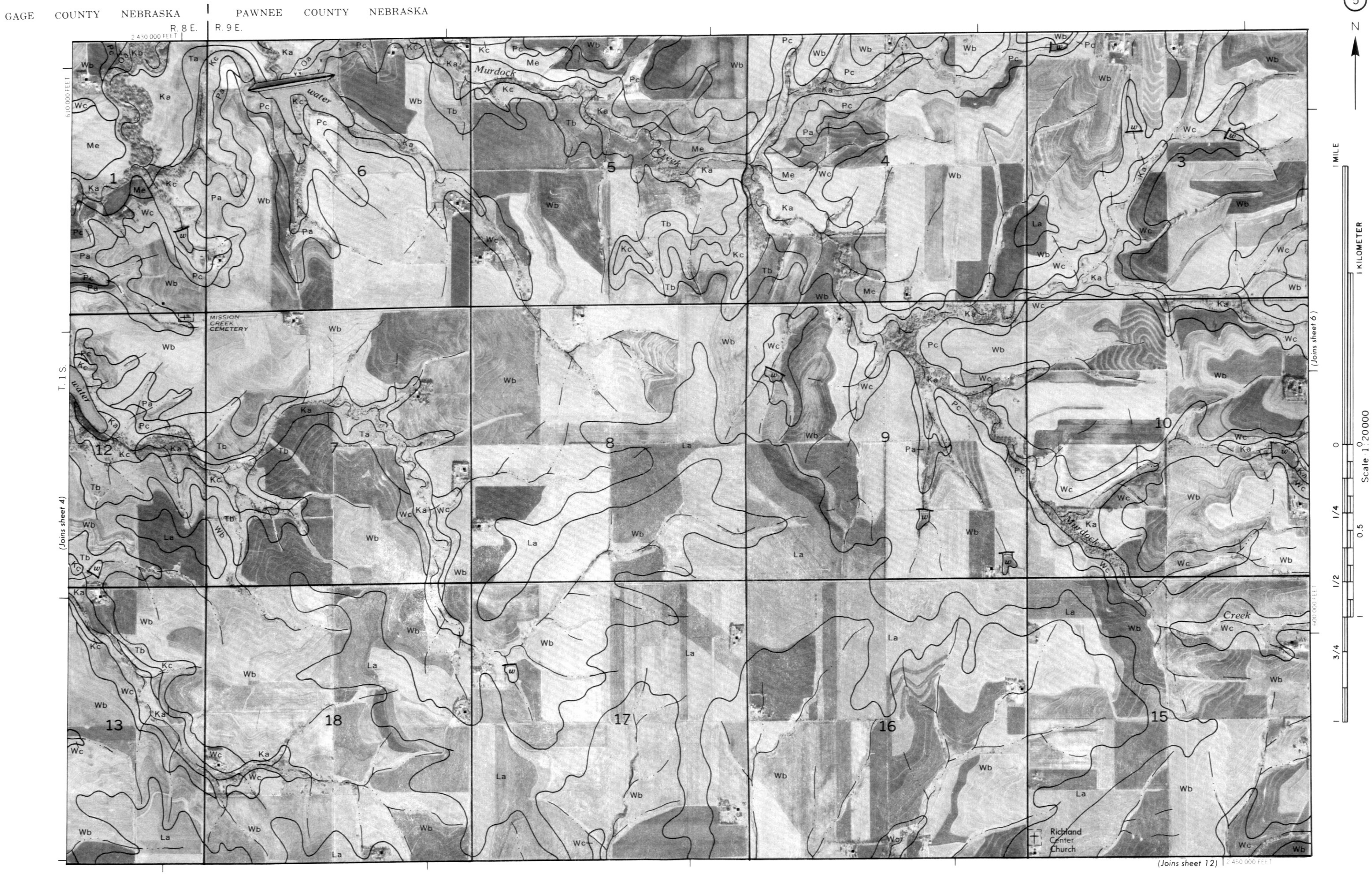
MARSHALL COUNTY, KANSAS — SHEET NUMBER 2

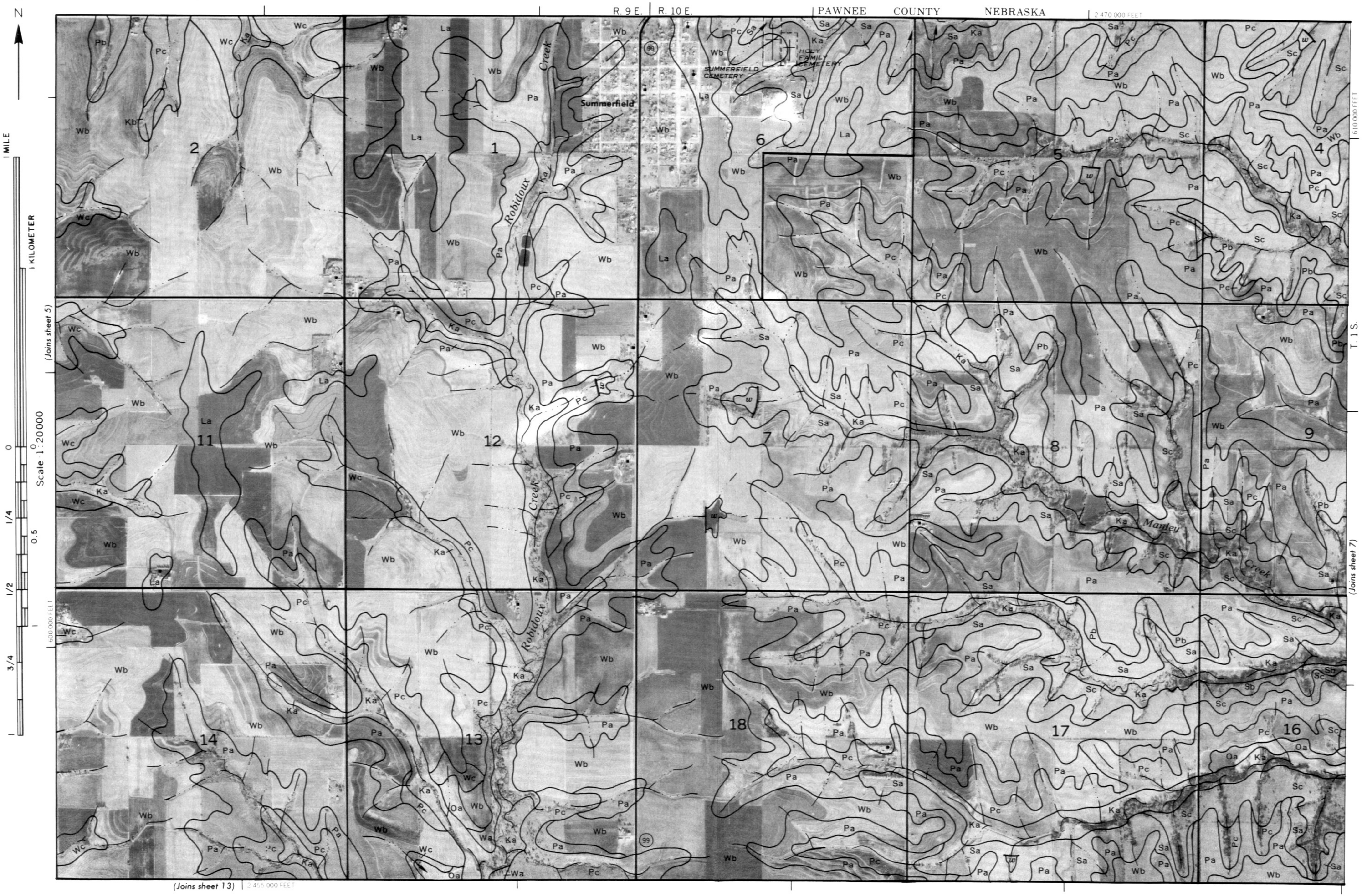



3
GAGE COUNTY NEBRASKA
2 385 000 FEET
R. 7 E.
R. 8 E.
T. 1 S.
N
BIG BLUE RIVER
Spring Creek
North Elm Creek
UNION PACIFIC
Oketo
233
1
2
3
6
7
10
11
12
13
14
15
18
(Joins sheet 2)
(Joins sheet 4)
(Joins sheet 10)
2 400 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

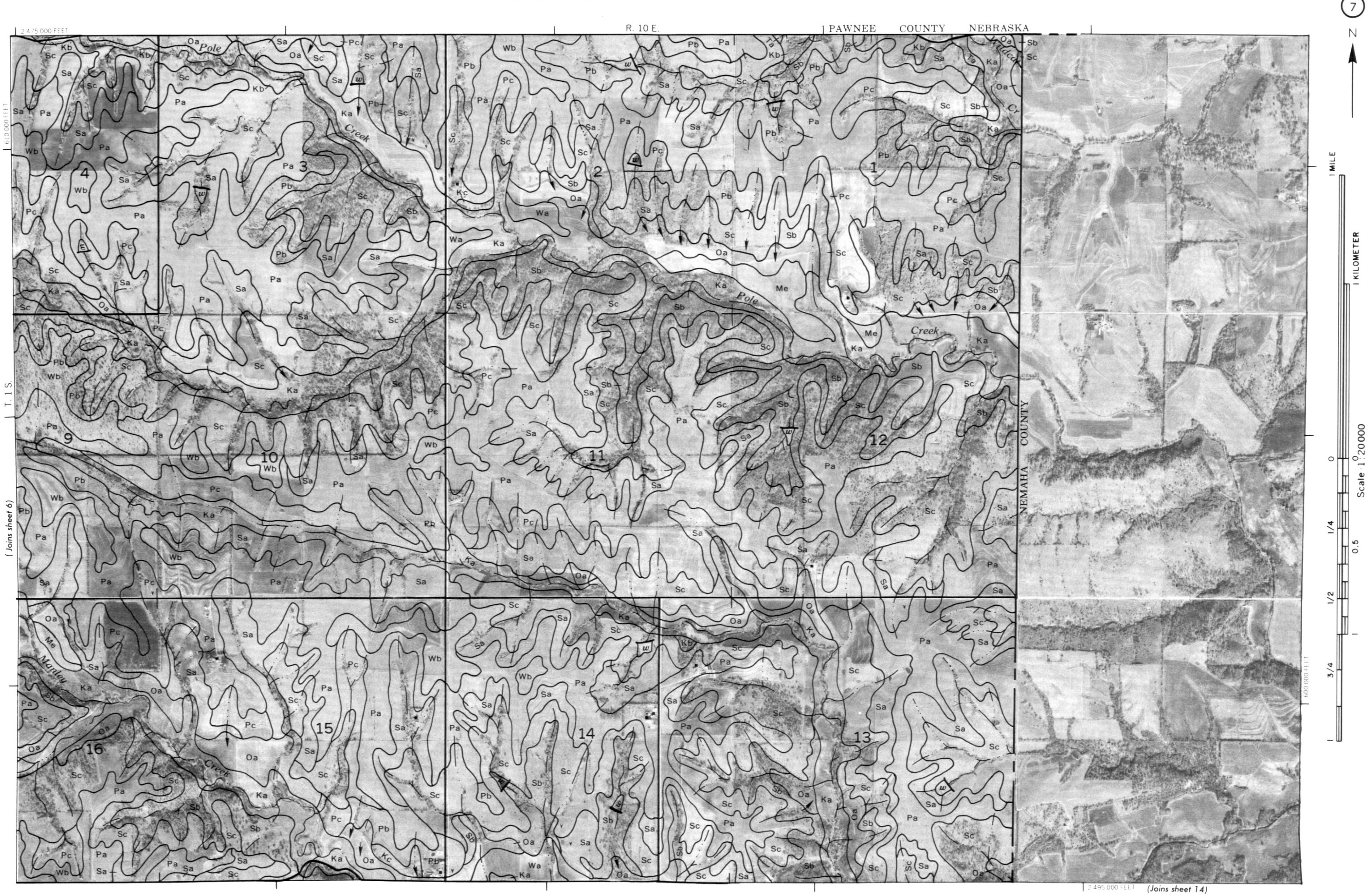

N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
R. 8 E.
GAGE COUNTY NEBRASKA
T. 1 S.
2 425 000 FEET
610 000 FEET
595 000 FEET
2 405 000 FEET
(Joins sheet 3)
(Joins sheet 5)
(Joins sheet 11)
Mission
Creek
North
Elm
Creek
North
Elm
Creek
Mission
Creek
water
water
water
water
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17

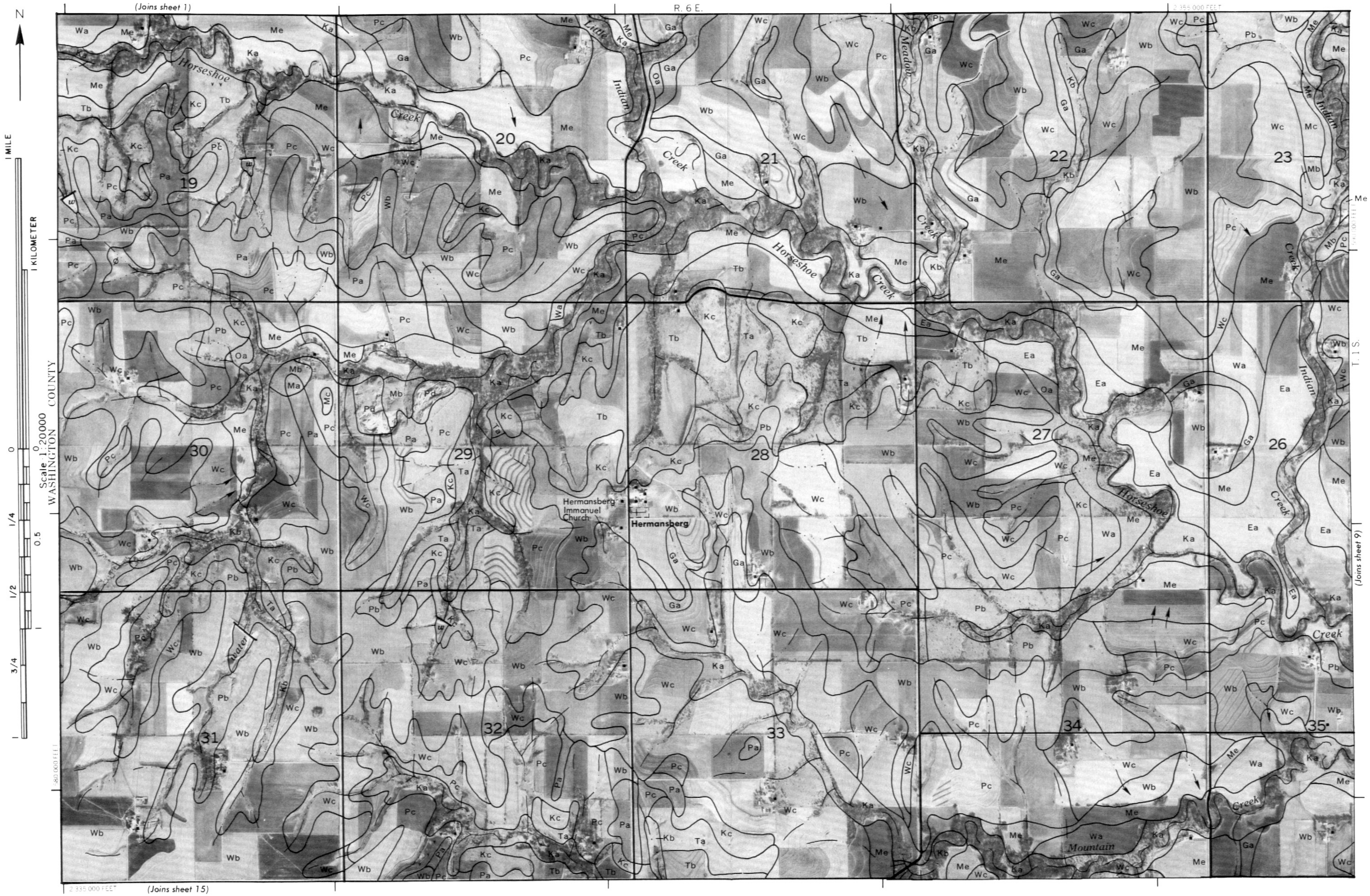
MARSHALL COUNTY, KANSAS — SHEET NUMBER 5

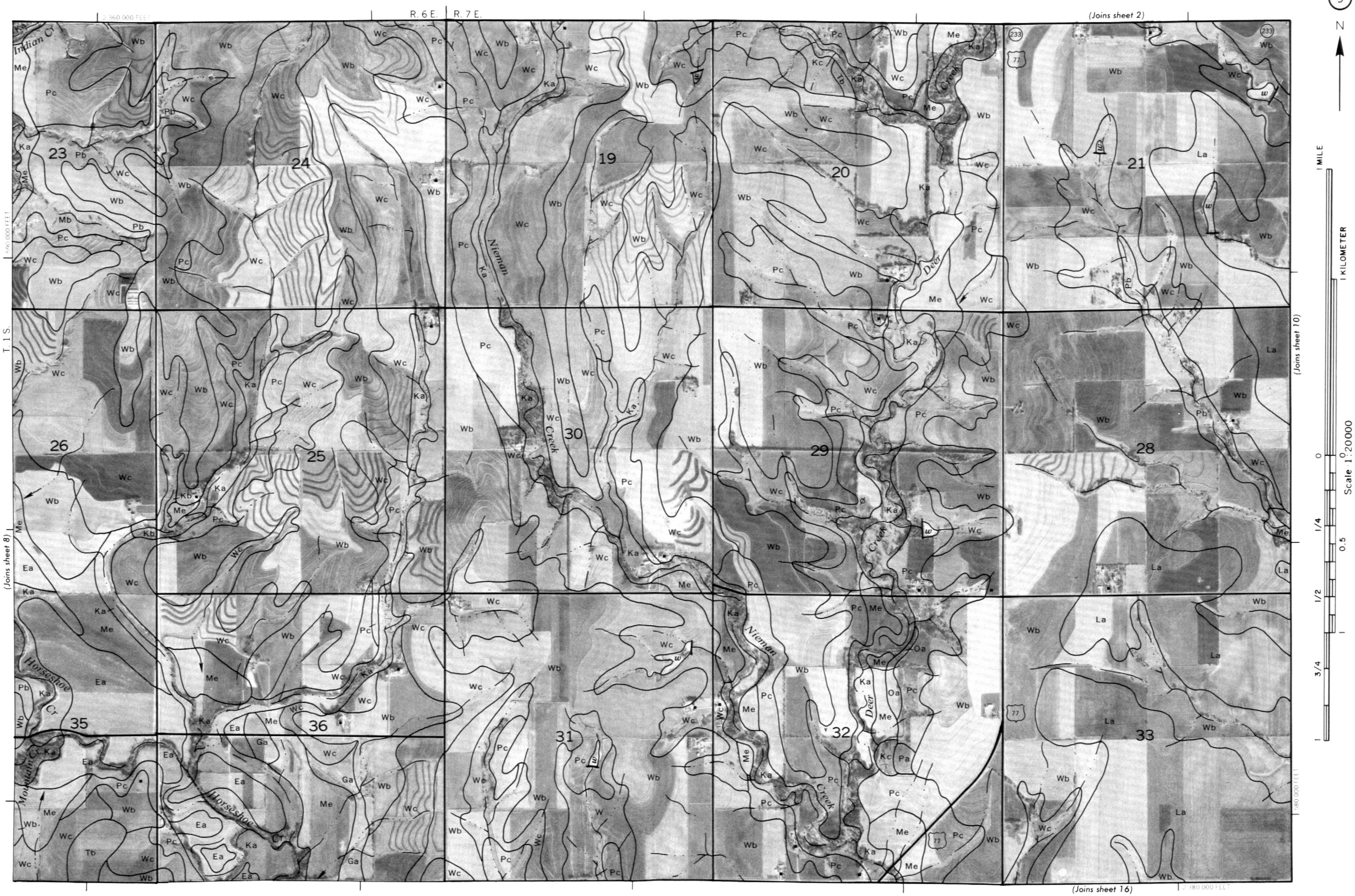



N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
R. 9 E.
R. 10 E.
PAWNEE COUNTY NEBRASKA
2 470 000 FEET
610 000 FEET
600 000 FEET
2 455 000 FEET
T. 1 S.
(Joins sheet 5)
(Joins sheet 7)
(Joins sheet 13)
Summerfield
SUMMERFIELD CEMETERY
HOLY FAMILY CEMETERY
Robidoux Creek
Manley Creek
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18
Wb
Wc
Pa
Pb
Pc
Ka
Kb
La
Sa
Sb
Sc
Oa
Wa
w

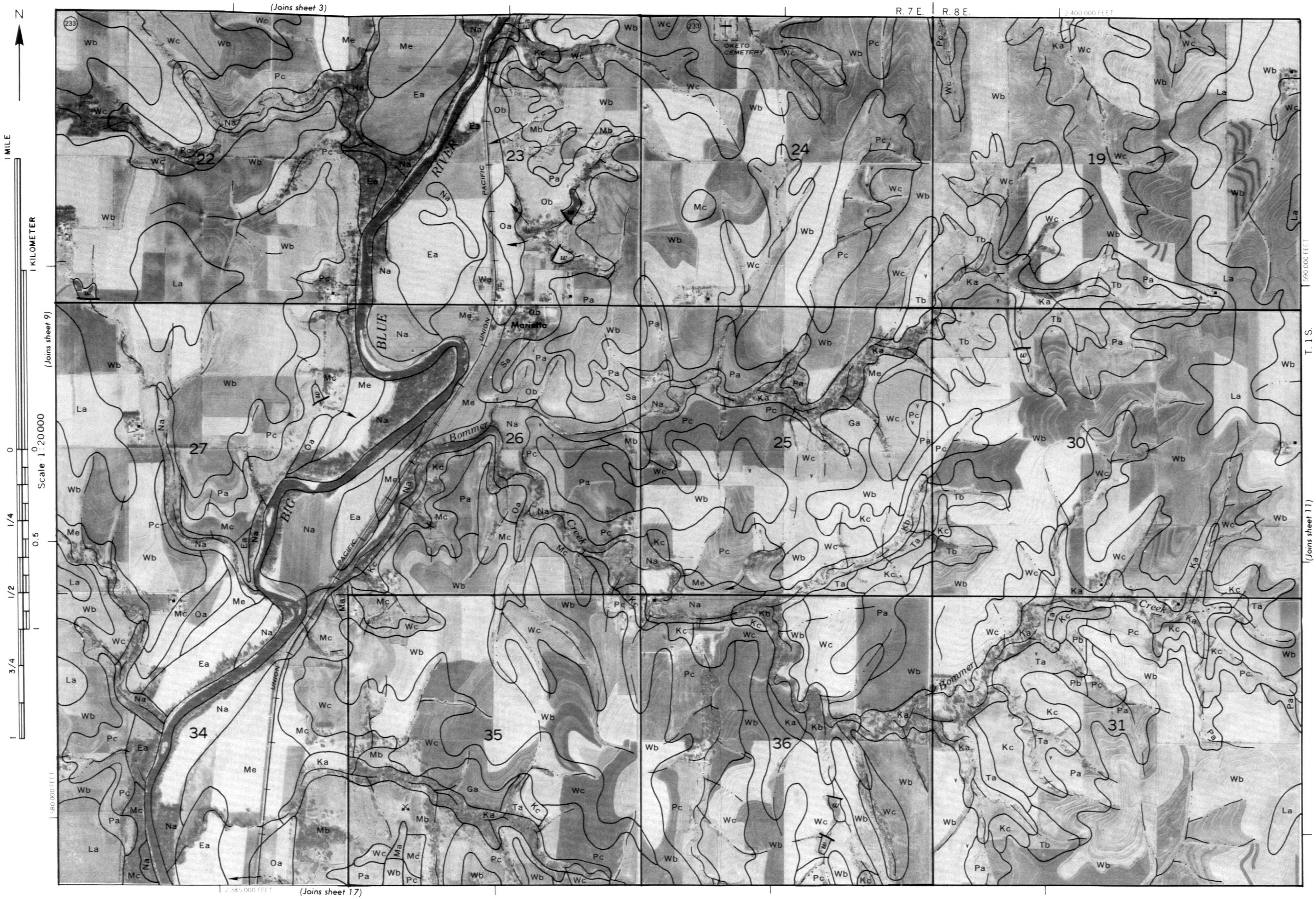
MARSHALL COUNTY KANSAS — SHEET NUMBER 7

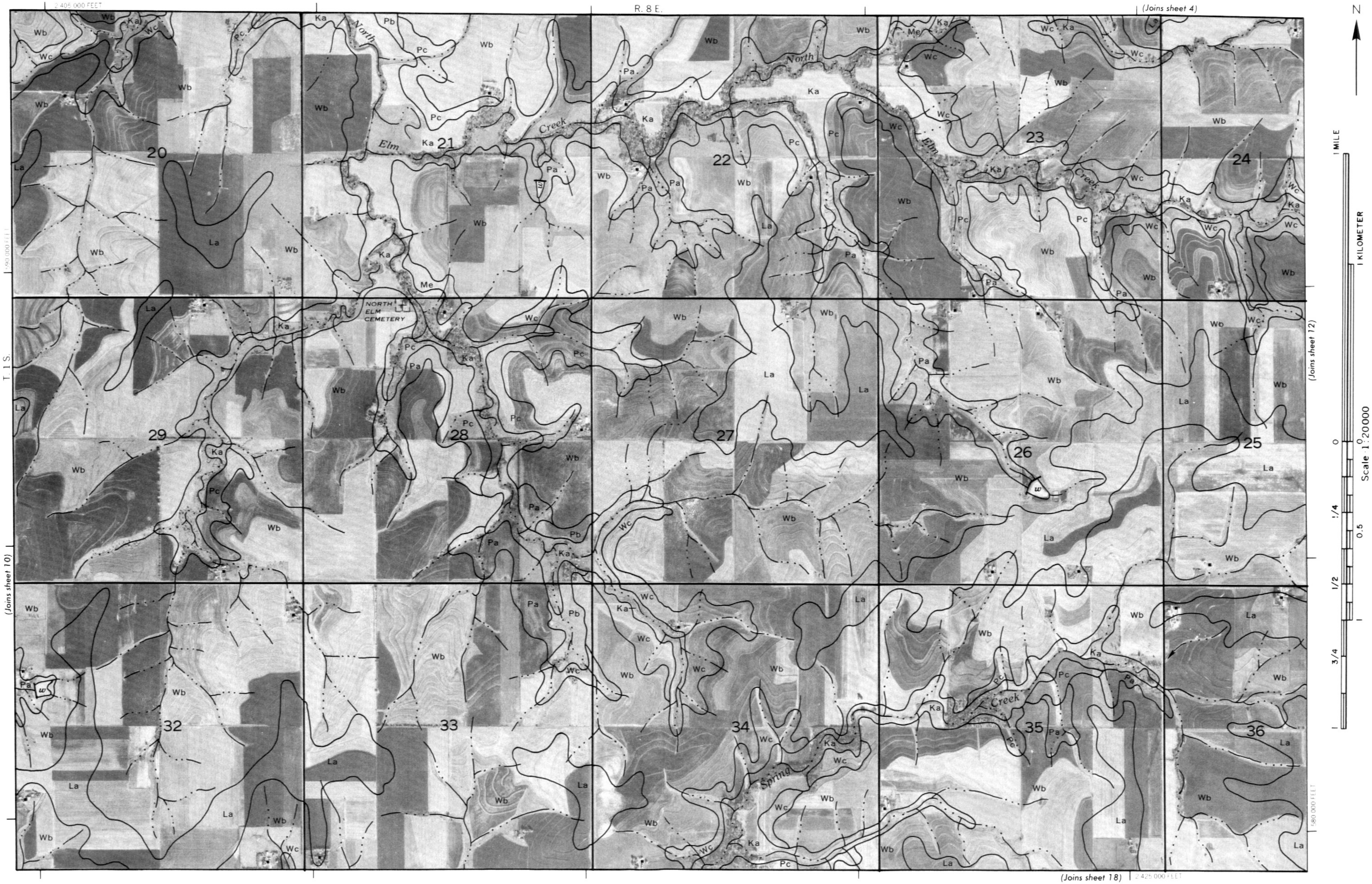


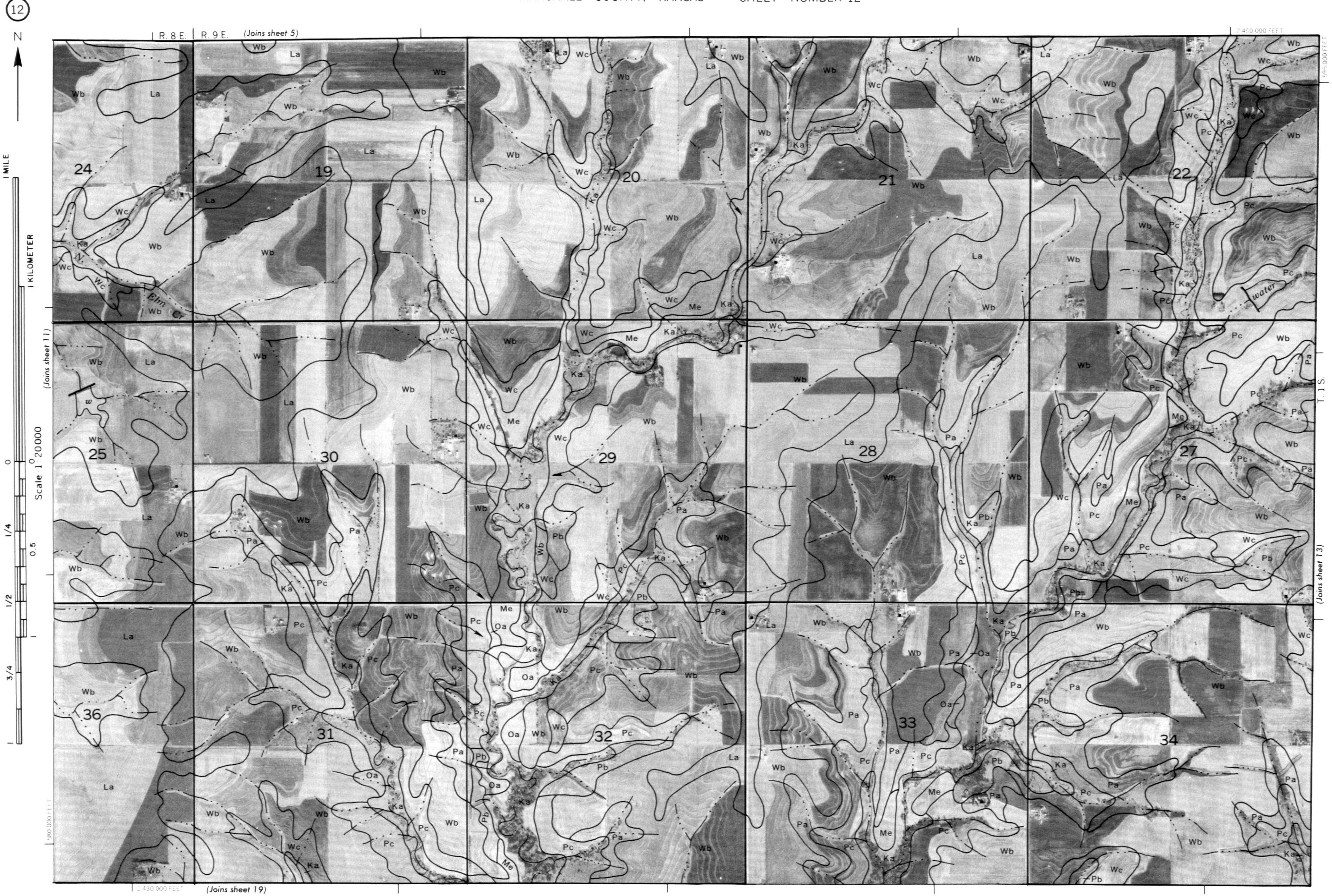

(Joins sheet 1)
R. 6 E.
T. 1 S.
(Joins sheet 9)
(Joins sheet 15)
WASHINGTON COUNTY
Scale 1:20000
1 MILE
1 KILOMETER
N
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
Horseshoe Creek
Little Indian Creek
Meadow Creek
Indian Creek
Mountain Creek
Hermansberg
Hermansberg Immanuel Church
2 355 000 FEET
2 335 000 FEET
980 000 FEET

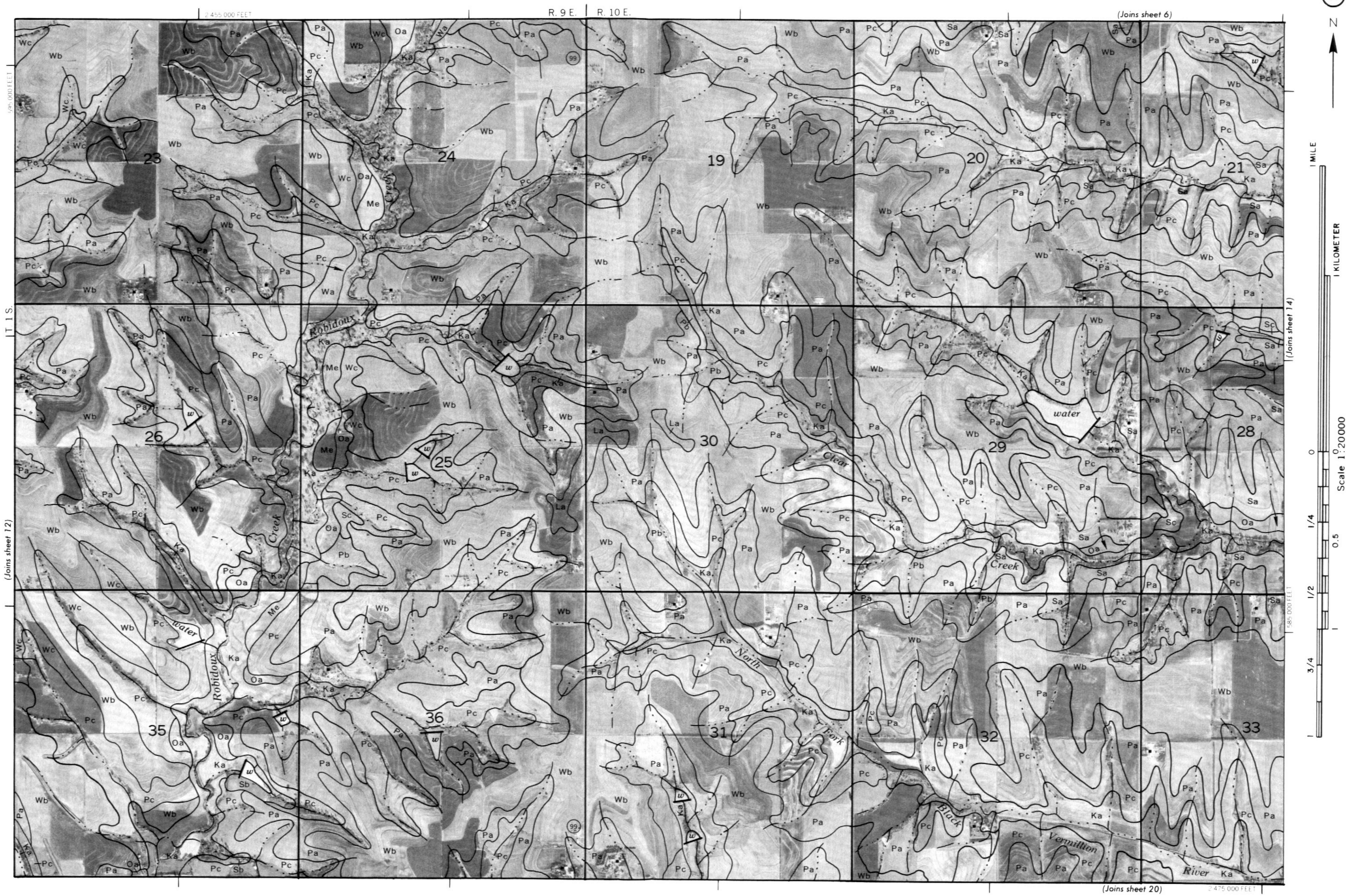

9
N
R. 6 E.
R. 7 E.
T. 1 S.
(Joins sheet 2)
(Joins sheet 10)
(Joins sheet 16)
(Joins sheet 8)
1 MILE
1 KILOMETER
Scale 1:20000
Indian Cr.
Nieman Creek
Deer Creek
Horseshoe Cr.
Mountain Cr.

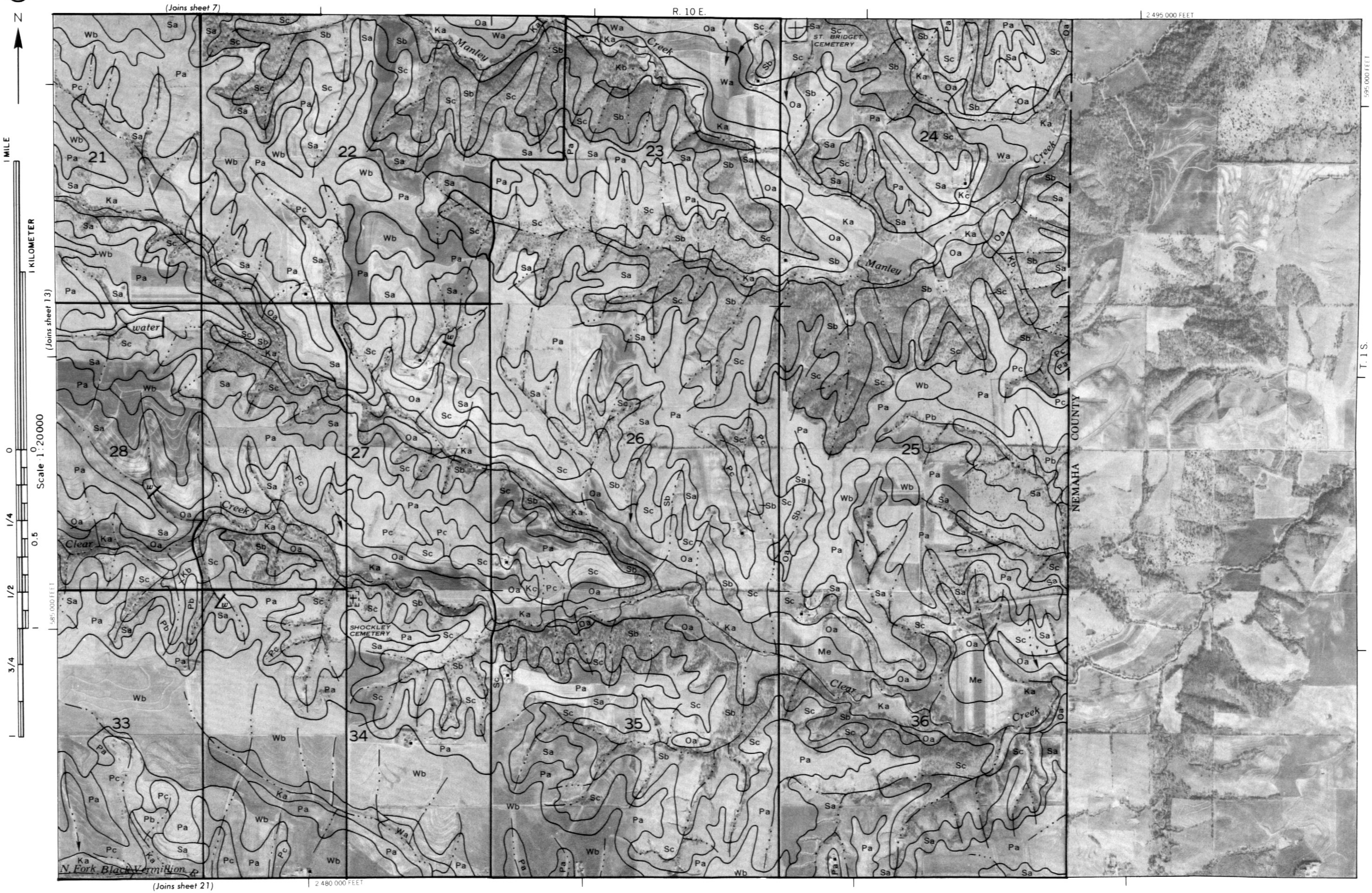
MARSHALL COUNTY, KANSAS — SHEET NUMBER 10




11
N
R. 8 E.
(Joins sheet 4)
(Joins sheet 12)
(Joins sheet 10)
(Joins sheet 18)
T. 1 S.
2 405 000 FEET
2 425 000 FEET
580 000 FEET
North Elm Creek
Spring
Creek
NORTH ELM CEMETERY
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
1 MILE
1 KILOMETER
Scale 1:20000

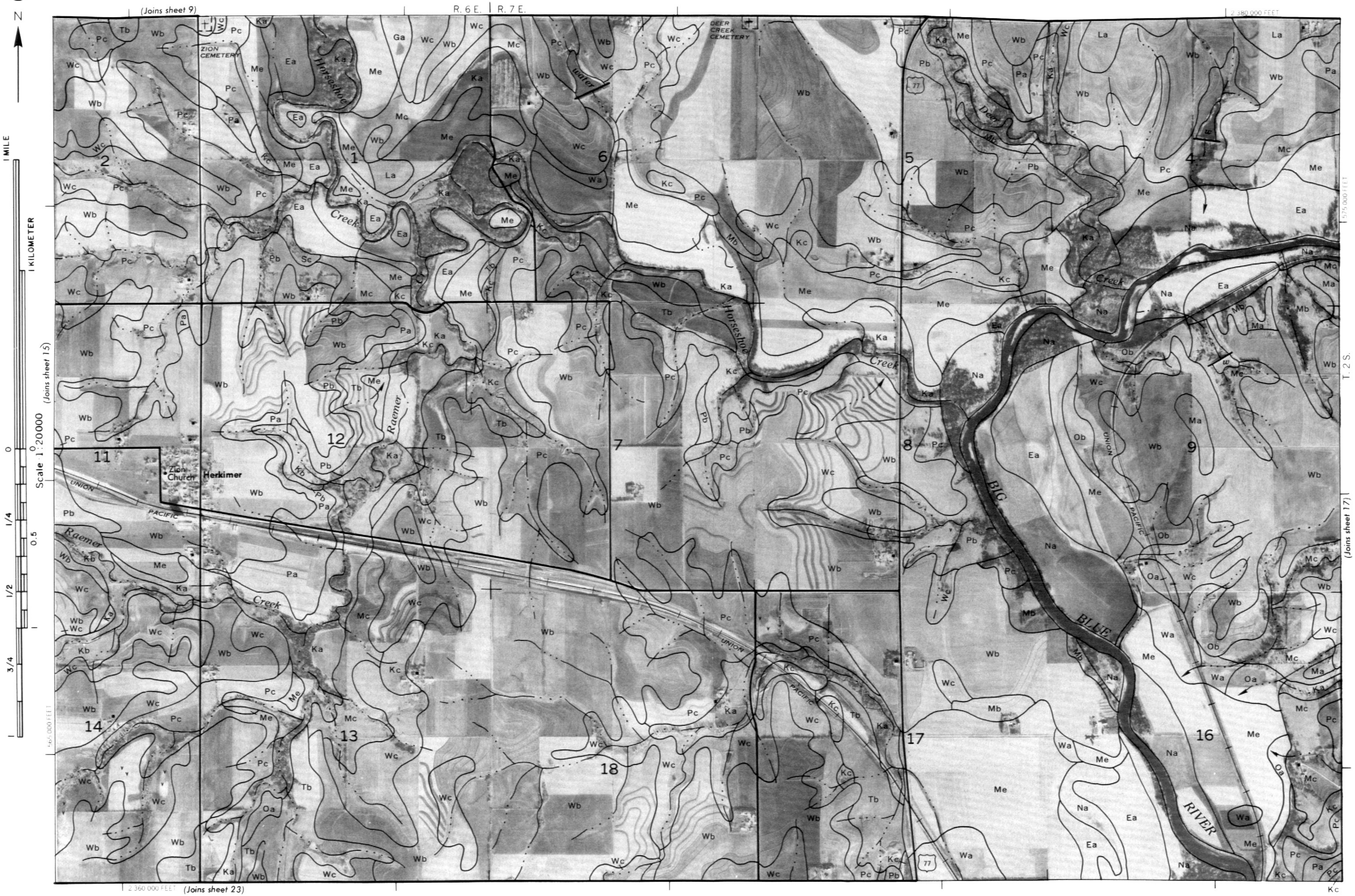

12
N
R. 8 E.
R. 9 E.
(Joins sheet 5)
(Joins sheet 11)
(Joins sheet 13)
(Joins sheet 19)
T. 1 S.
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
2 450 000 FEET
2 430 000 FEET
580 000 FEET
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36
Elm Cr.
water

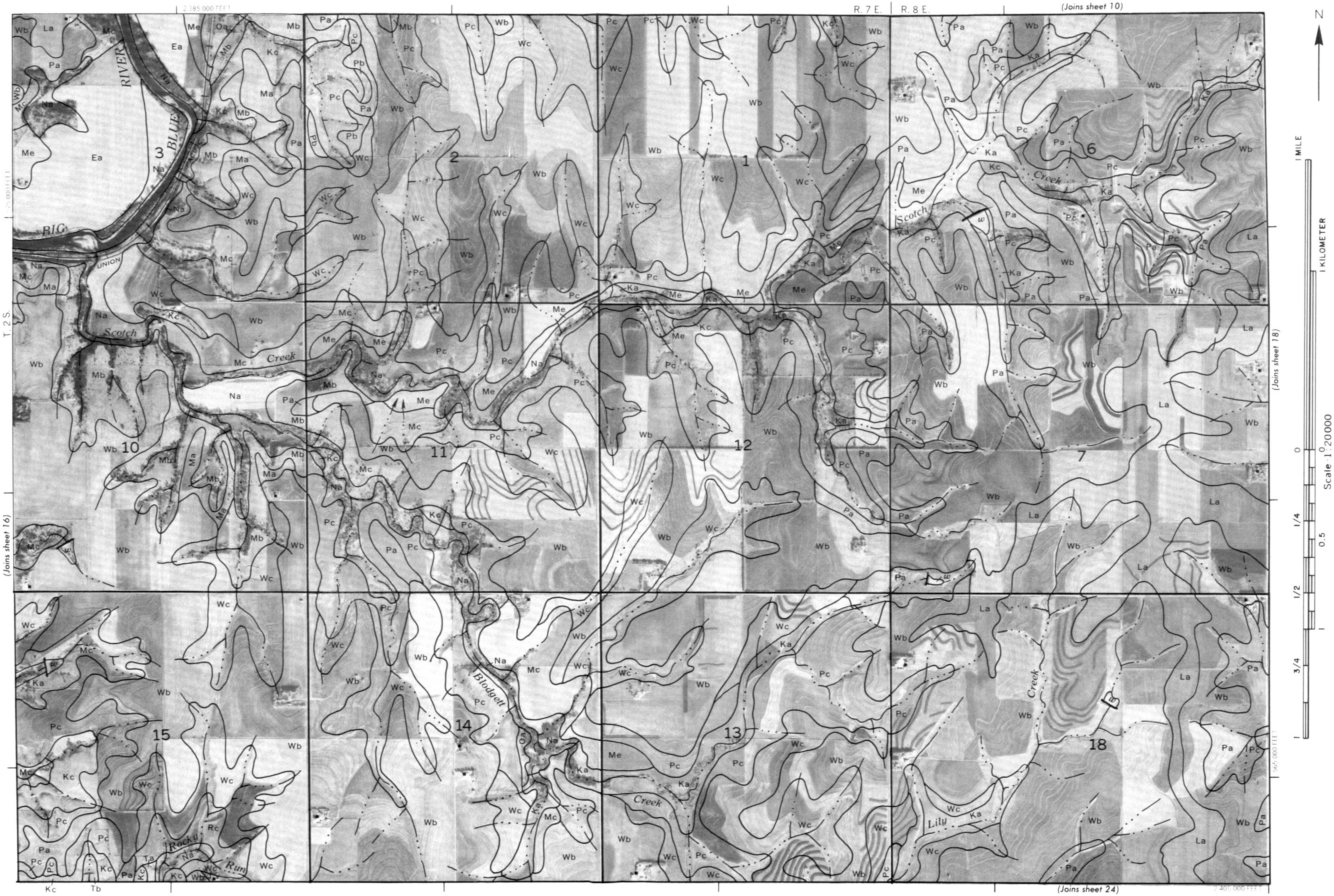

13
N
R. 9 E.
R. 10 E.
T 1 S.
2 455 000 FEET
2 475 000 FEET
585 000 FEET
(Joins sheet 6)
(Joins sheet 14)
(Joins sheet 12)
(Joins sheet 20)
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33
Robidoux Creek
Clear Creek
North Fork
Black Vermillion River
water
99
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5


N
(Joins sheet 7)
R. 10 E.
2 495 000 FEET
595 000 FEET
(Joins sheet 13)
T. 1 S.
NEMAHA COUNTY
ST. BRIDGET CEMETERY
SHOCKLEY CEMETERY
Manley Creek
Clear Creek
N. Fork Black Vermillion R.
water
21
22
23
24
25
26
27
28
33
34
35
36
585 000 FEET
2 480 000 FEET
(Joins sheet 21)
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

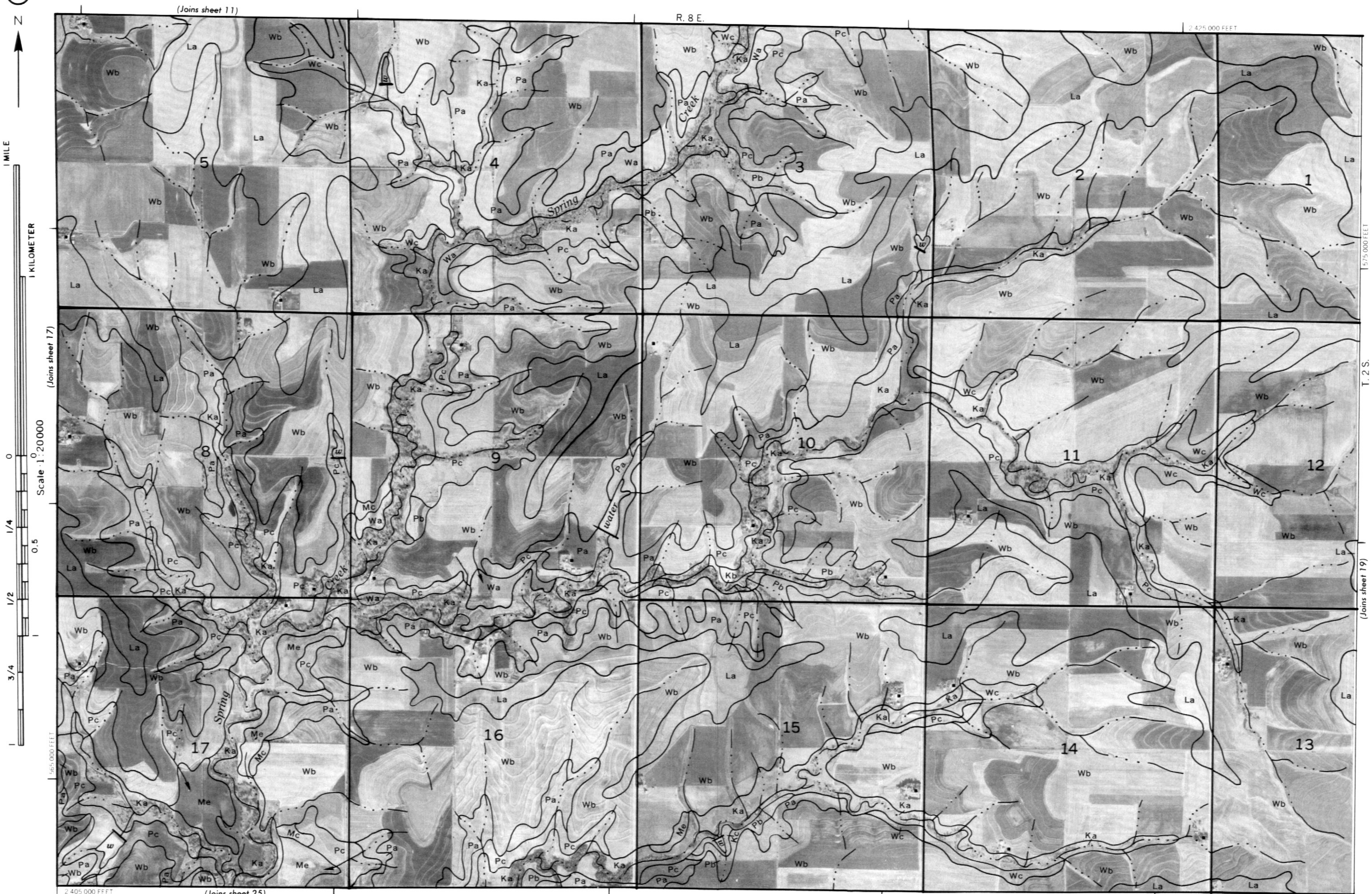

15
N
R. 6 E.
(Joins sheet 8)
(Joins sheet 16)
(Joins sheet 22)
T. 2 S.
WASHINGTON COUNTY
2 335 000 FEET
575 000 FEET
565 000 FEET
2 355 000 FEET
Bremen
UNION PACIFIC
Mountain Creek
Raemer Creek
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

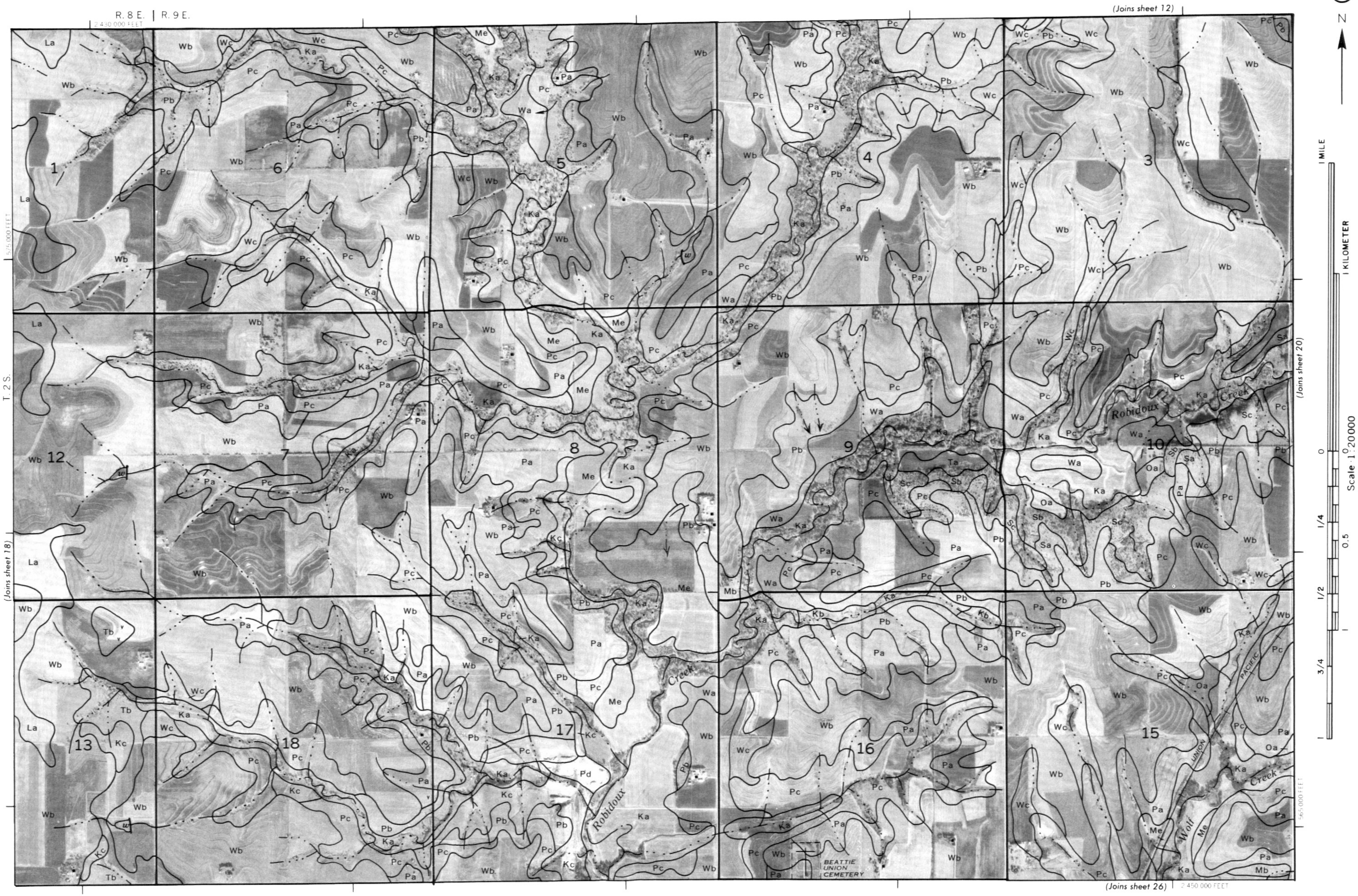
MARSHALL COUNTY, KANSAS — SHEET NUMBER 16

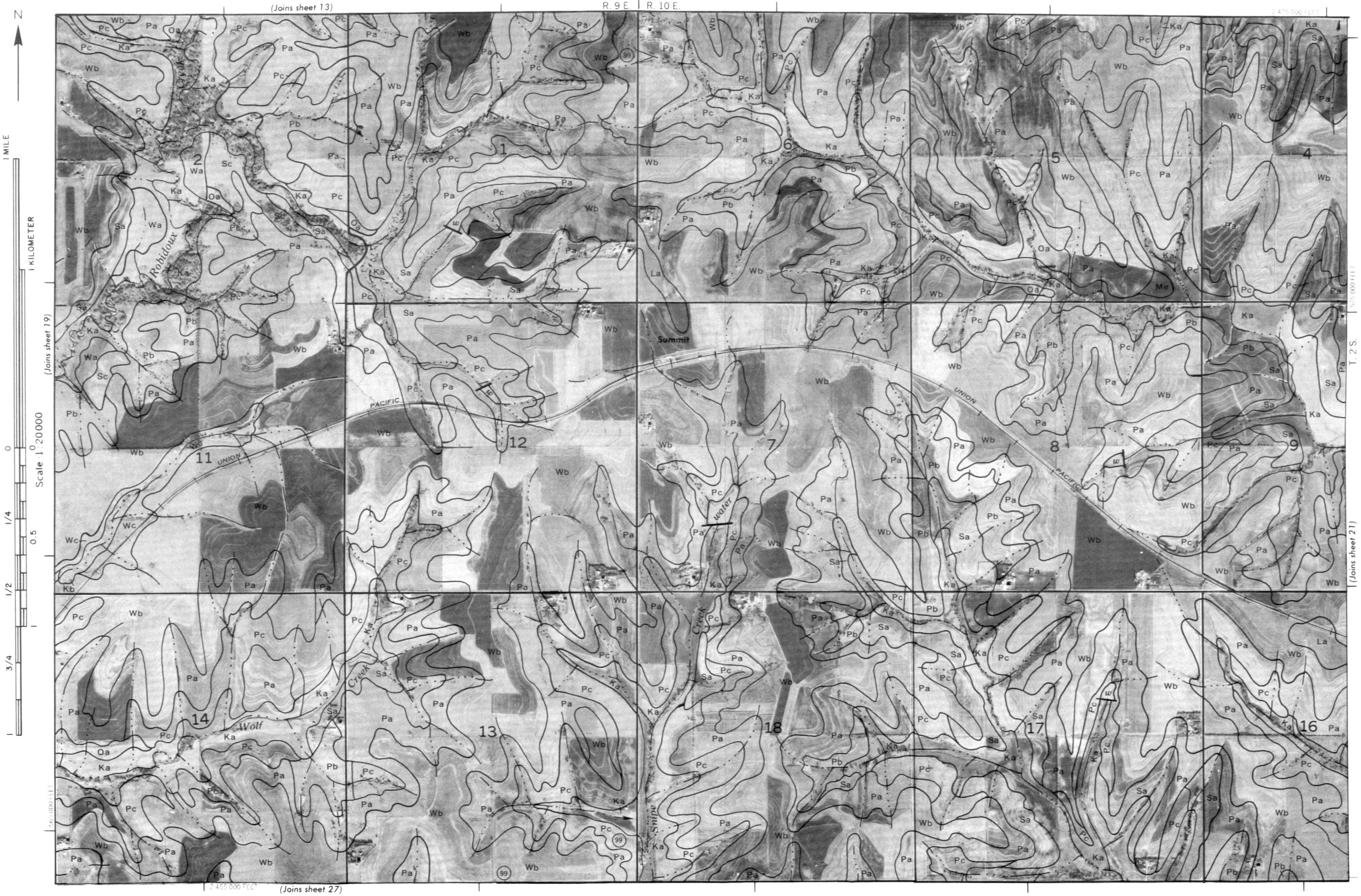


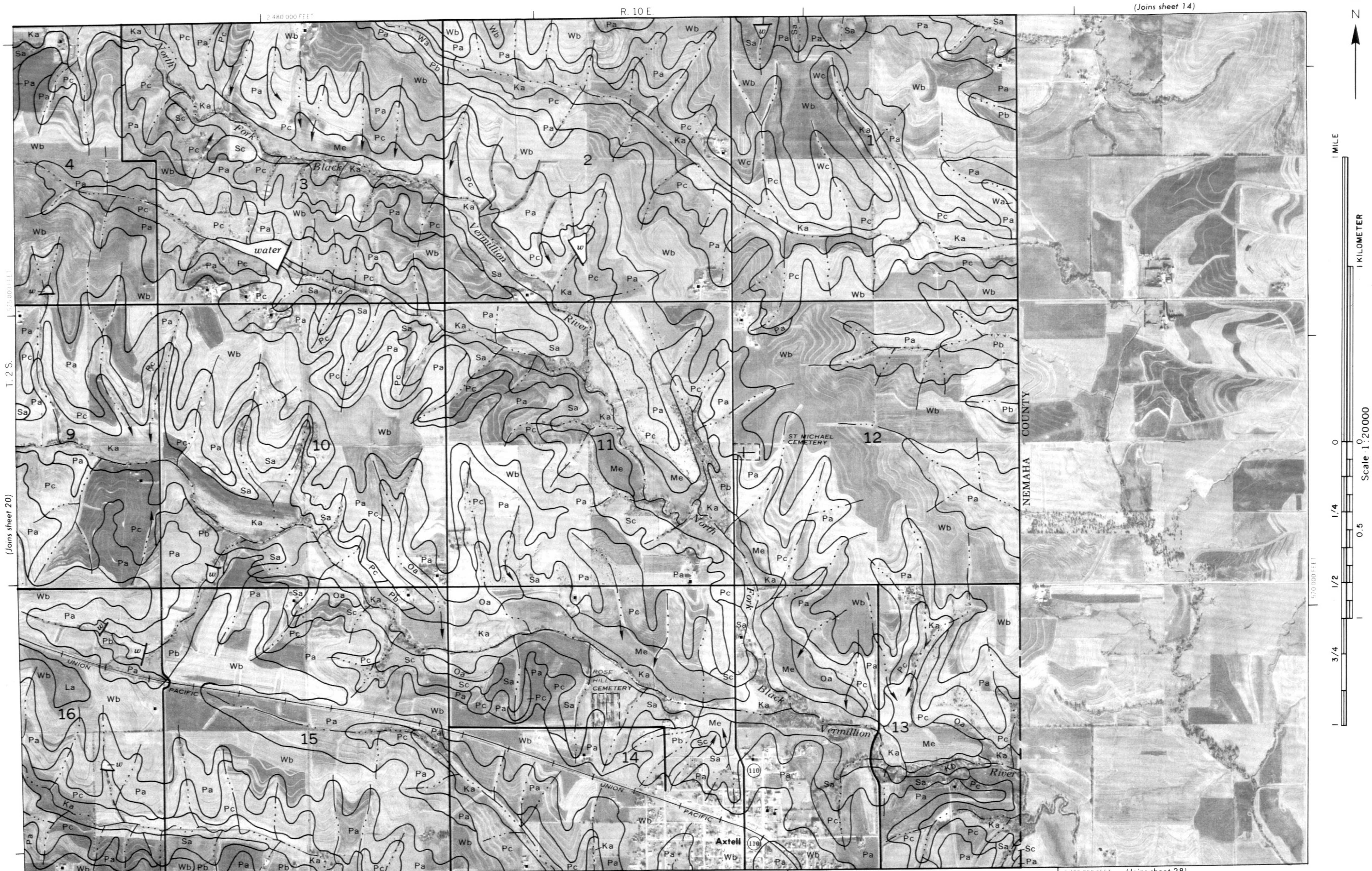

17
N
(Joins sheet 10)
(Joins sheet 16)
(Joins sheet 18)
(Joins sheet 24)
R. 7 E.
R. 8 E.
T. 2 S.
BIG BLUE RIVER
Scotch Creek
Blodgett
Creek
Lily
Rocky Run
UNION
1 MILE
1 KILOMETER
Scale 1:20000

MARSHALL COUNTY, KANSAS — SHEET NUMBER 18

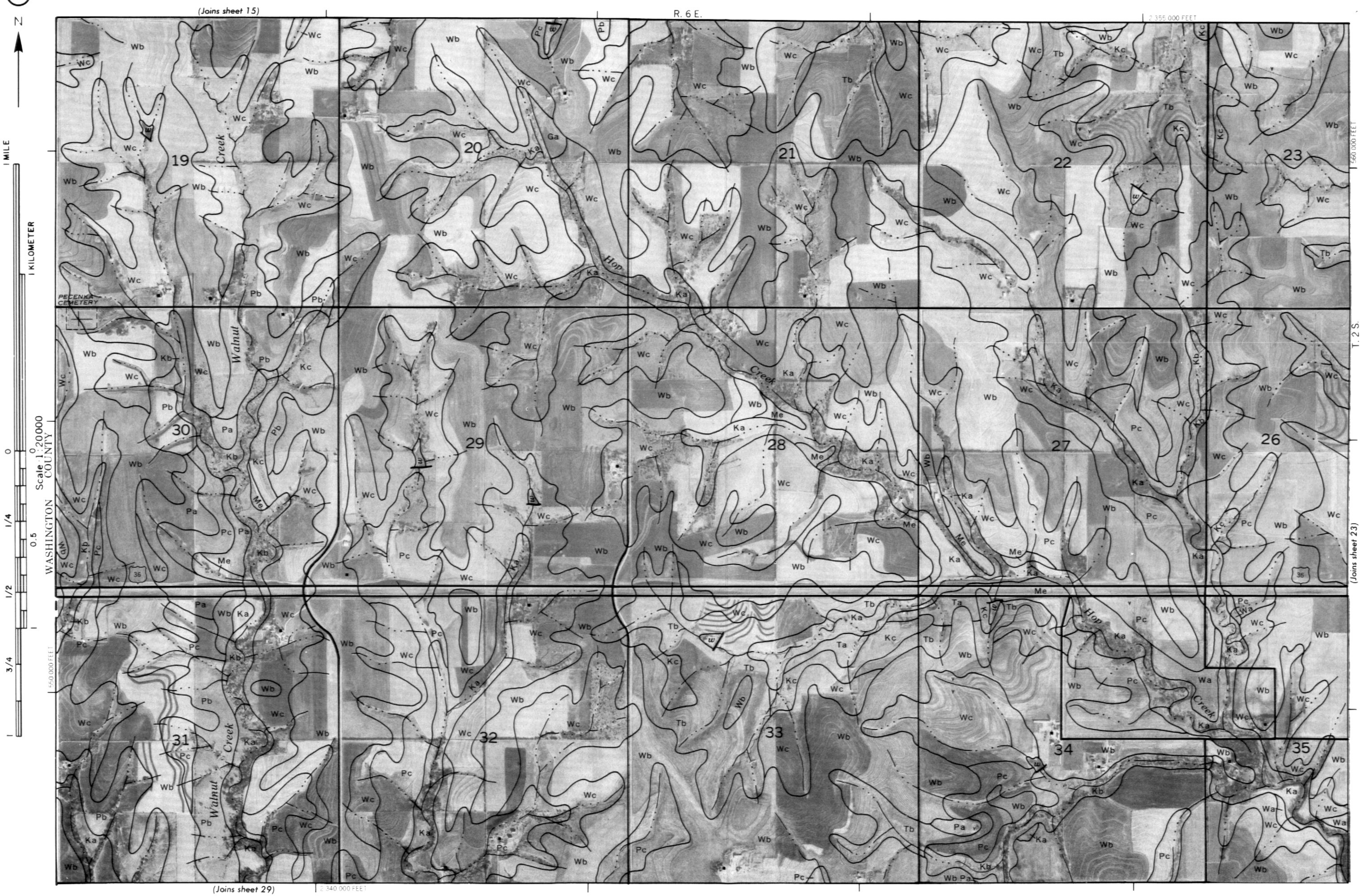


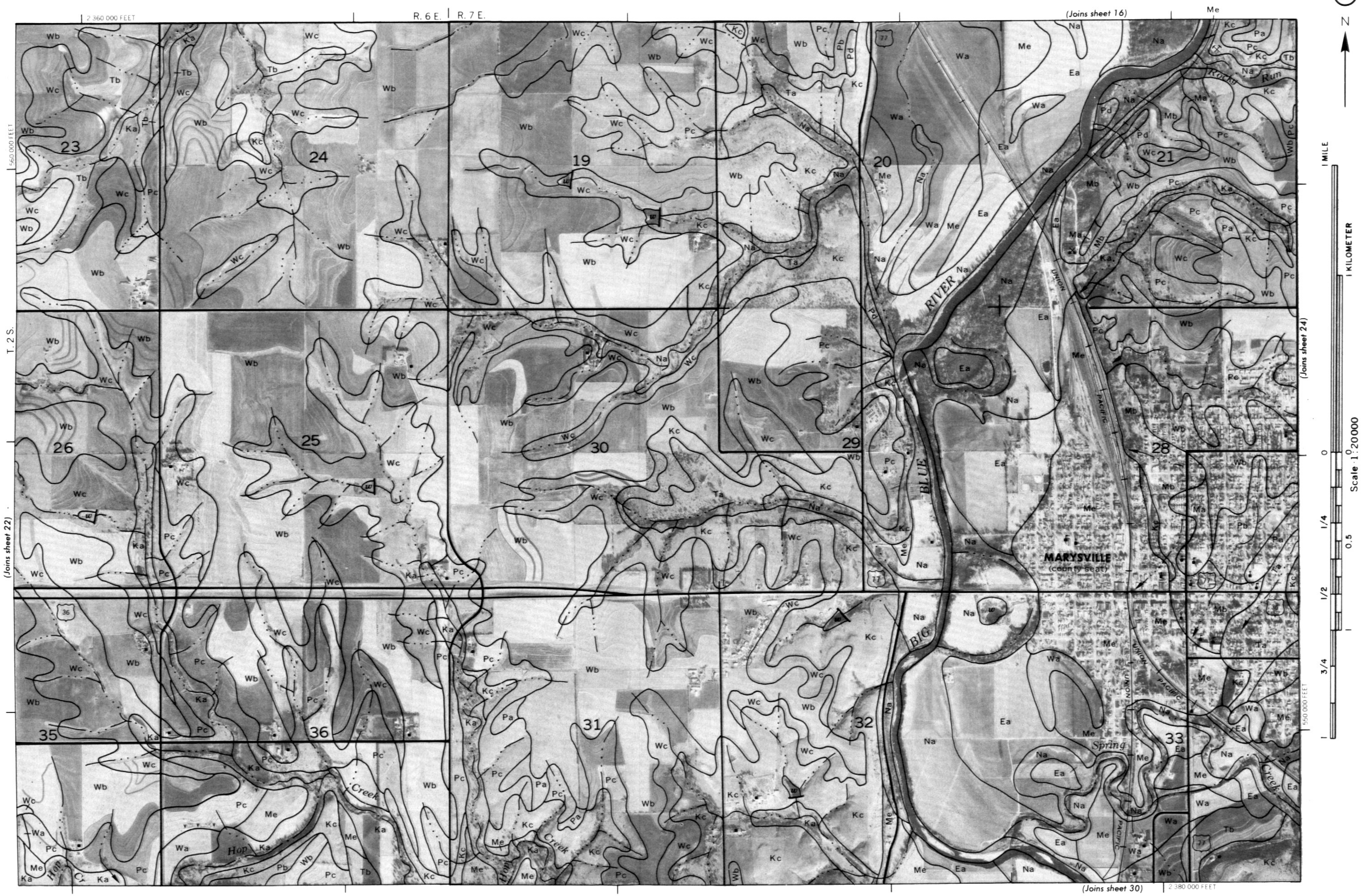

R. 8 E.
R. 9 E.
2 430 000 FEET
(Joins sheet 12)
N
(Joins sheet 20)
(Joins sheet 18)
(Joins sheet 26)
2 450 000 FEET
T. 2 S.
Robidoux Creek
Robidoux
Creek
Wolf
Creek
UNION PACIFIC
BEATTIE UNION CEMETERY
1 MILE
1 KILOMETER
Scale 1:20 000
0
1/4
1/2
3/4
1
0
0.5
1
1
2
3
4
5
6
7
8
9
10
12
13
15
16
17
18

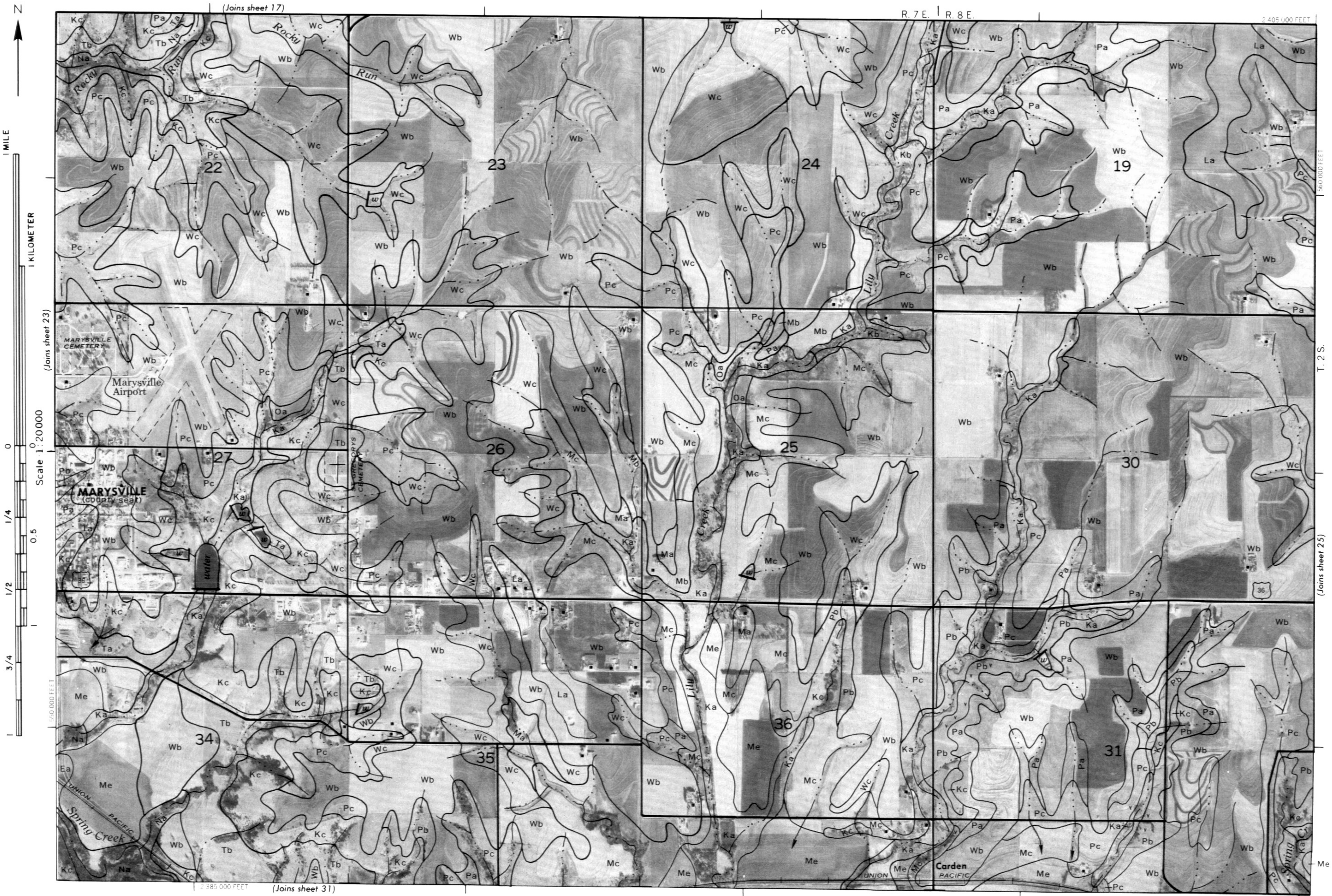

N
(Joins sheet 13)
R. 9 E.
R. 10 E.
(Joins sheet 19)
(Joins sheet 21)
(Joins sheet 27)
T. 2 S.
Scale 1:20000
1 MILE
1 KILOMETER
Summit
UNION PACIFIC
Robidoux Creek
Wolf Creek
Snipe Creek
water
2 475 000 FEET
2 455 000 FEET


21
(Joins sheet 14)
R. 10 E.
T. 2 S.
(Joins sheet 20)
(Joins sheet 28)
NEMAHA COUNTY
North Fork Black Vermillion River
ST MICHAEL CEMETERY
ROSE HILL CEMETERY
UNION PACIFIC
Axtell
water
2 480 000 FEET
2 495 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

MARSHALL COUNTY, KANSAS — SHEET NUMBER 22

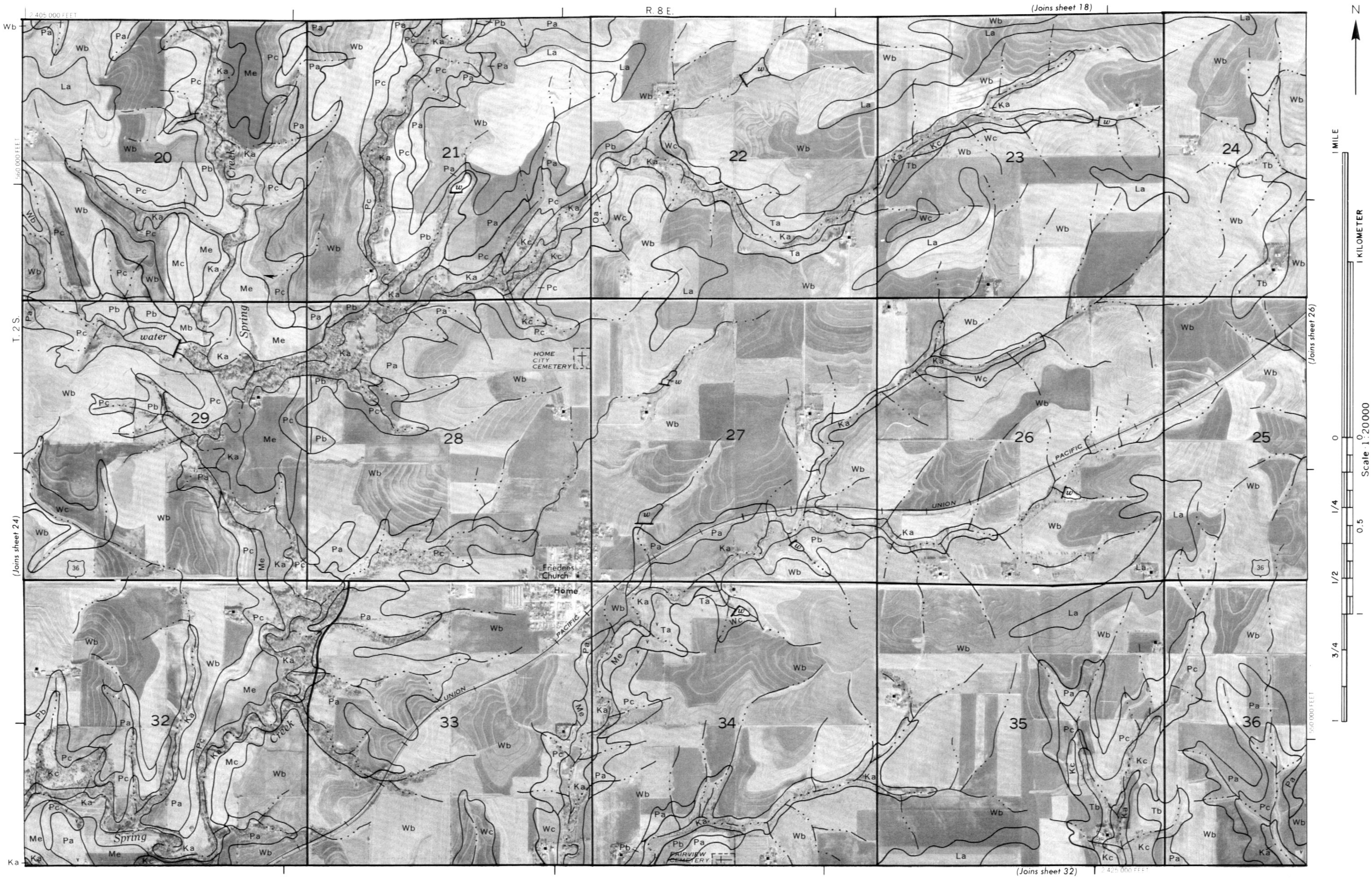


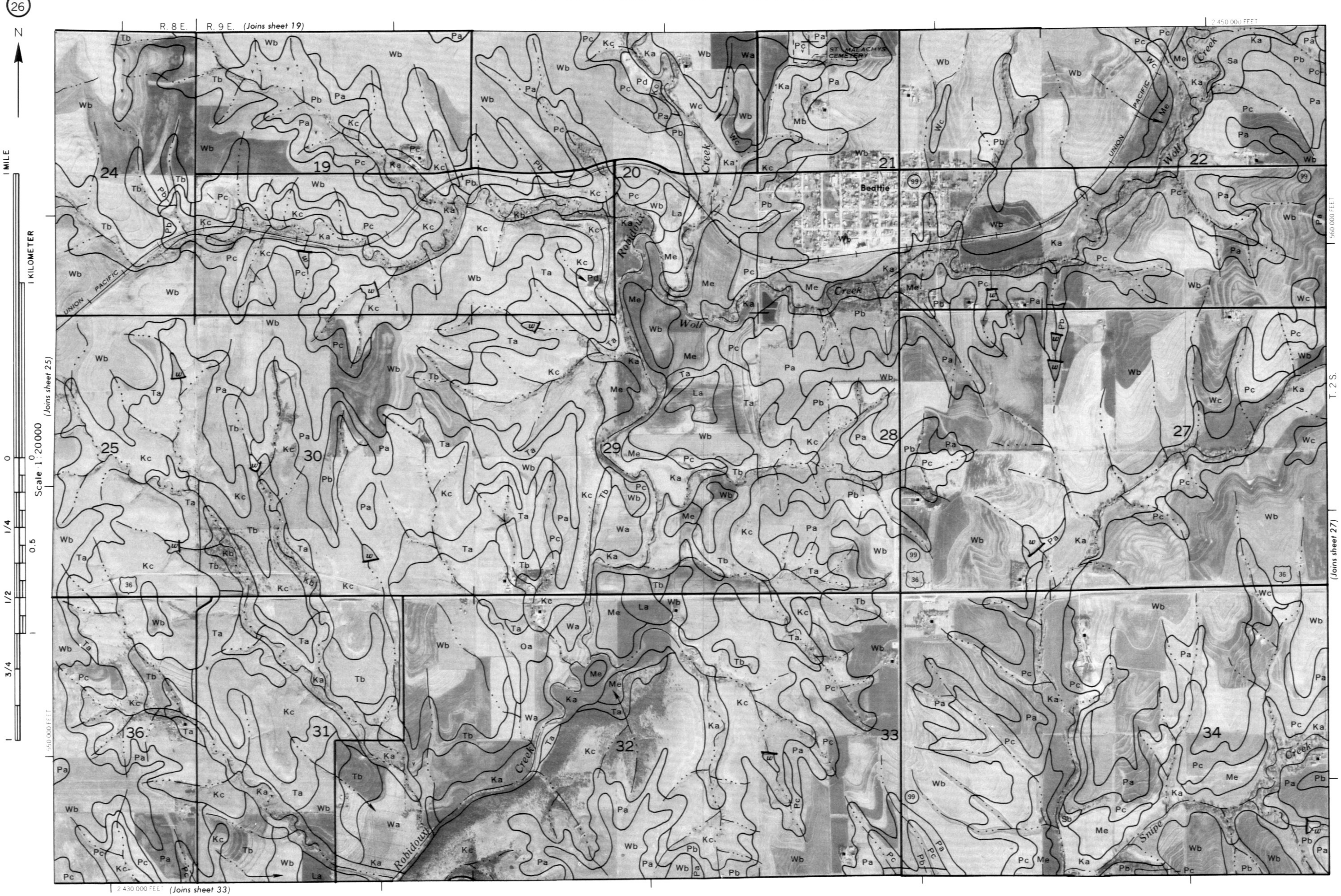

23
(Joins sheet 16)
(Joins sheet 22)
(Joins sheet 24)
(Joins sheet 30)
R. 6 E.
R. 7 E.
T. 2 S.
2 360 000 FEET
2 380 000 FEET
560 000 FEET
550 000 FEET
MARYSVILLE
(county seat)
BIG BLUE RIVER
Rocky Run
Spring Creek
Hop Creek
UNION PACIFIC
N
1 MILE
1 KILOMETER
Scale 1:20000

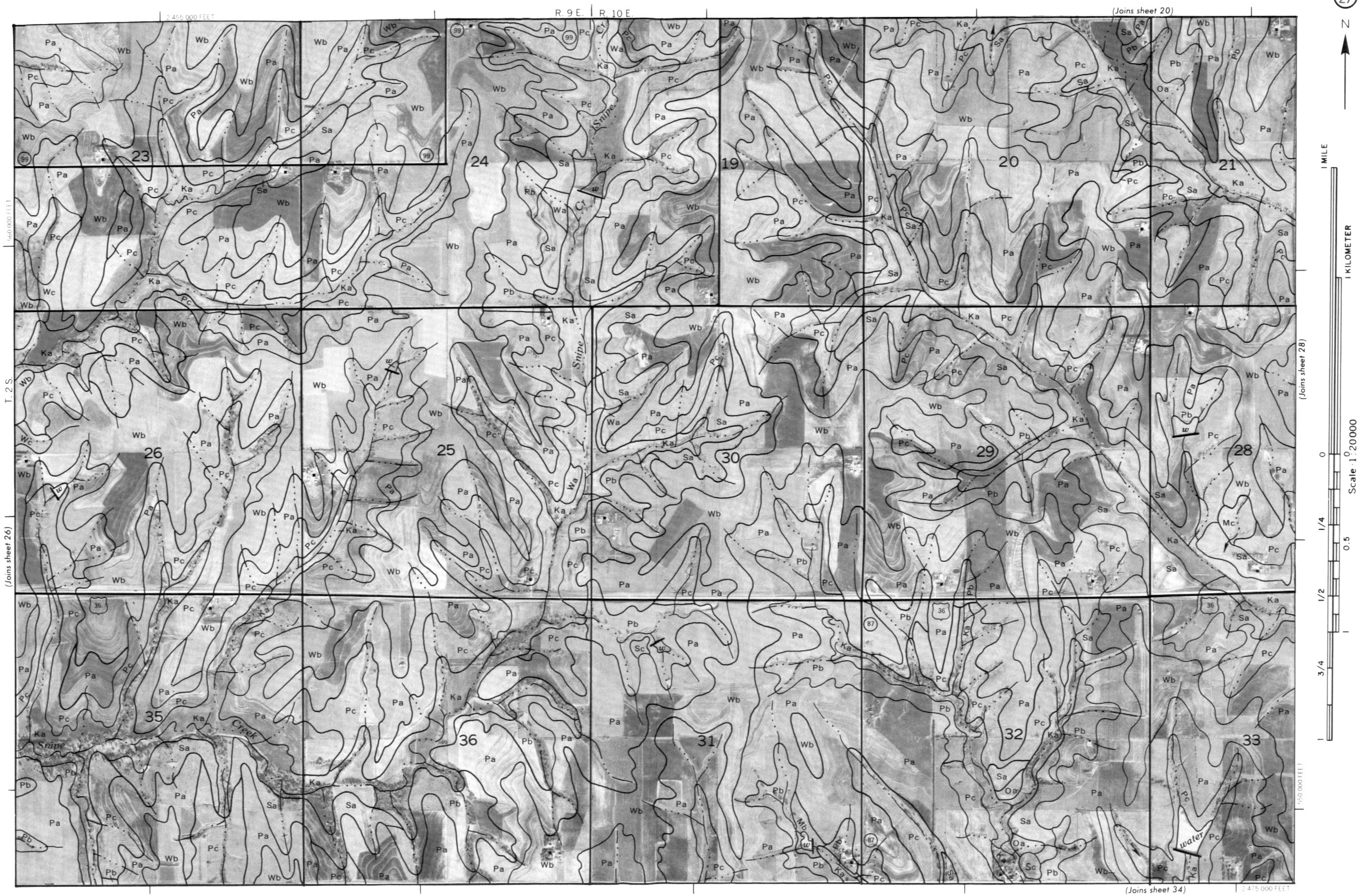

N
(Joins sheet 17)
(Joins sheet 23)
(Joins sheet 25)
(Joins sheet 31)
R. 7 E.
R. 8 E.
T. 2 S.
2 405 000 FEET
560 000 FEET
550 000 FEET
2 385 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
1
MARSHALL CEMETERY
Marysville Airport
MARYSVILLE
(county seat)
ST. GREGORY'S CEMETERY
Rocky Run
Lily Creek
Spring Creek
Spring Cr.
UNION PACIFIC
Carden
water
22
23
24
19
27
26
25
30
34
35
36
31
36

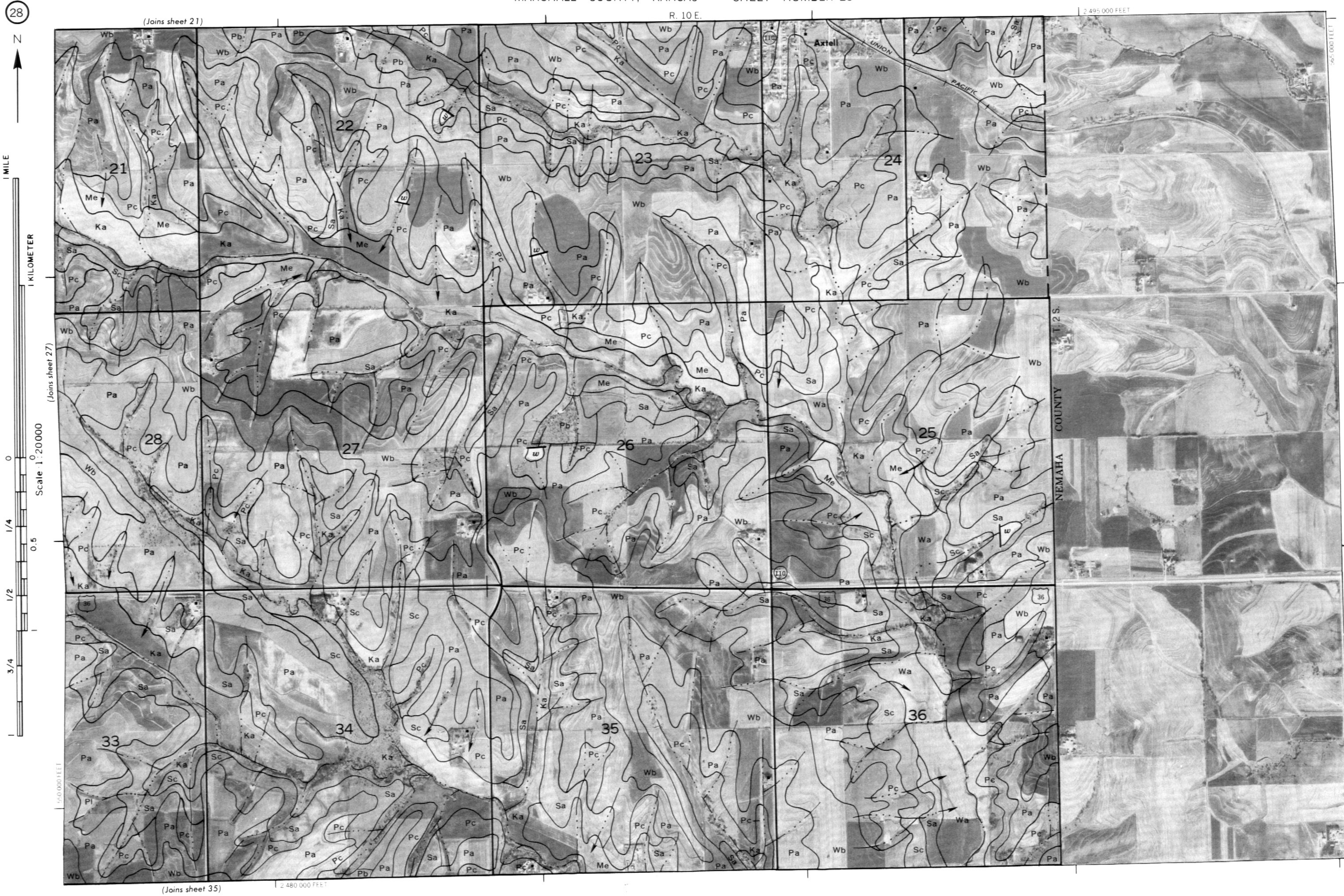
MARSHALL COUNTY, KANSAS — SHEET NUMBER 25

25

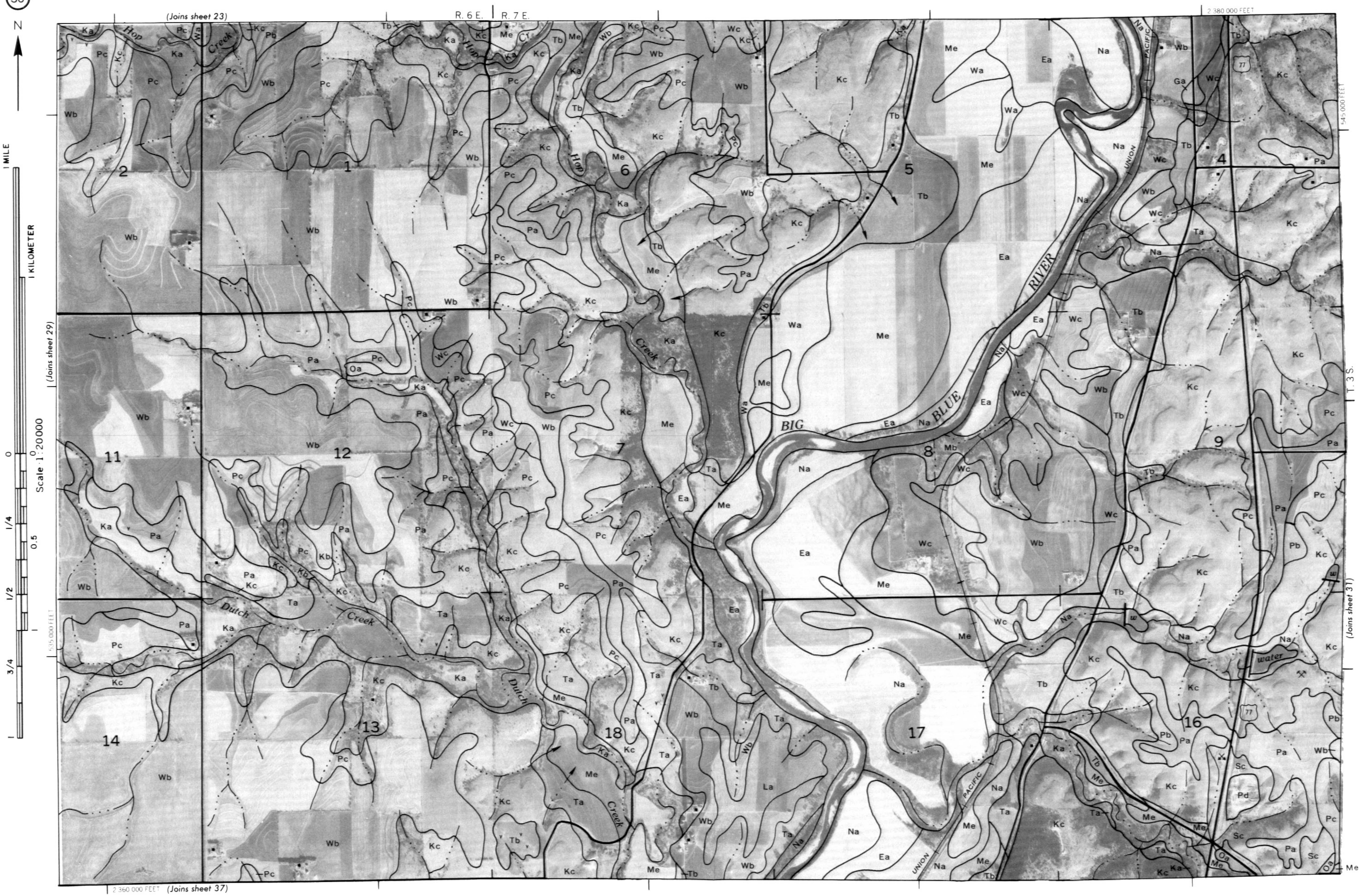


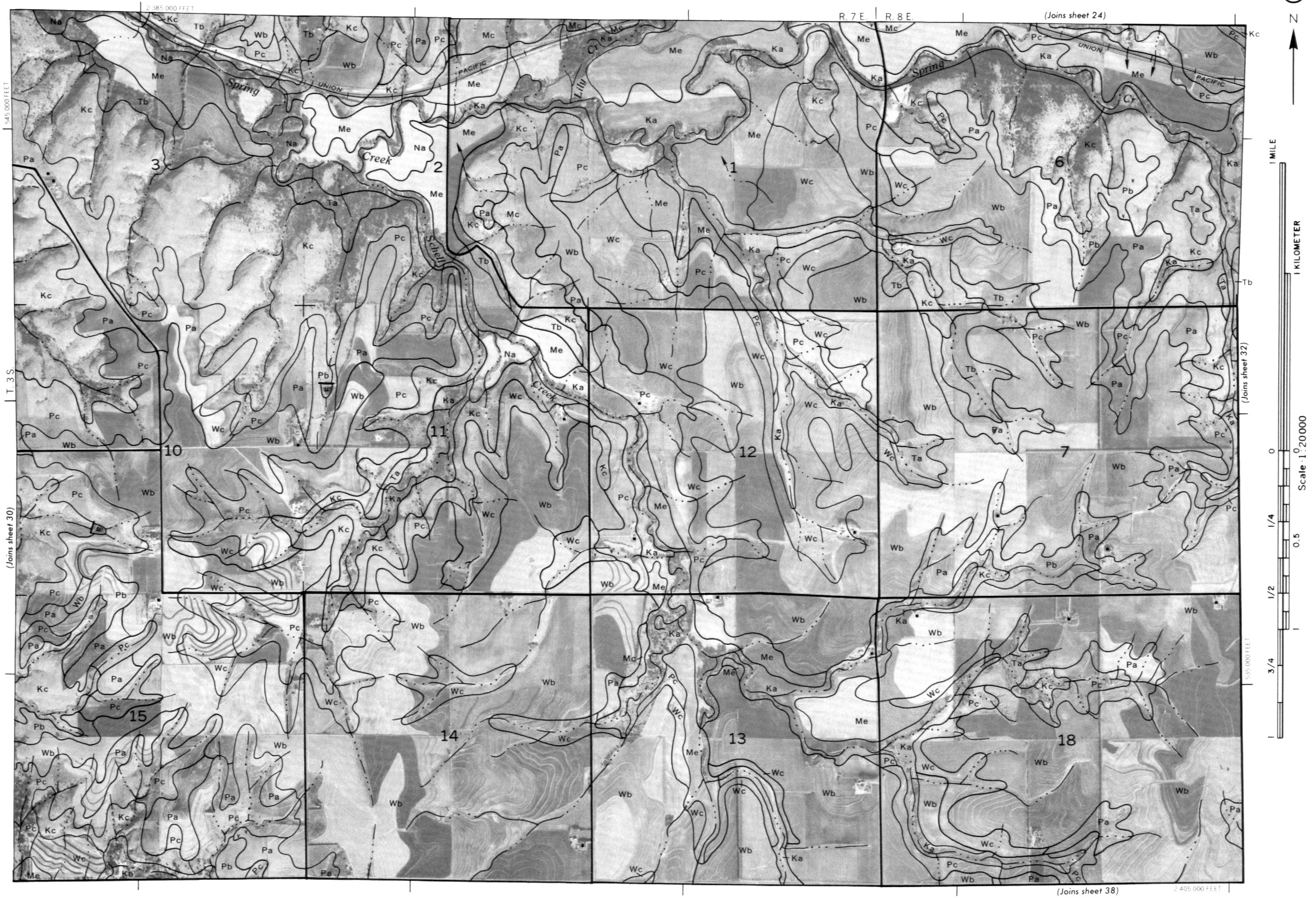

26
N
R. 8 E.
R. 9 E.
(Joins sheet 19)
(Joins sheet 25)
(Joins sheet 27)
(Joins sheet 33)
T. 2 S.
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
2 450 000 FEET
560 000 FEET
550 000 FEET
2 430 000 FEET
UNION PACIFIC
Beattie
ST. MALACHYS CEMETERY
Robidoux Creek
Wolf Creek
Snipe Creek
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36
99
36

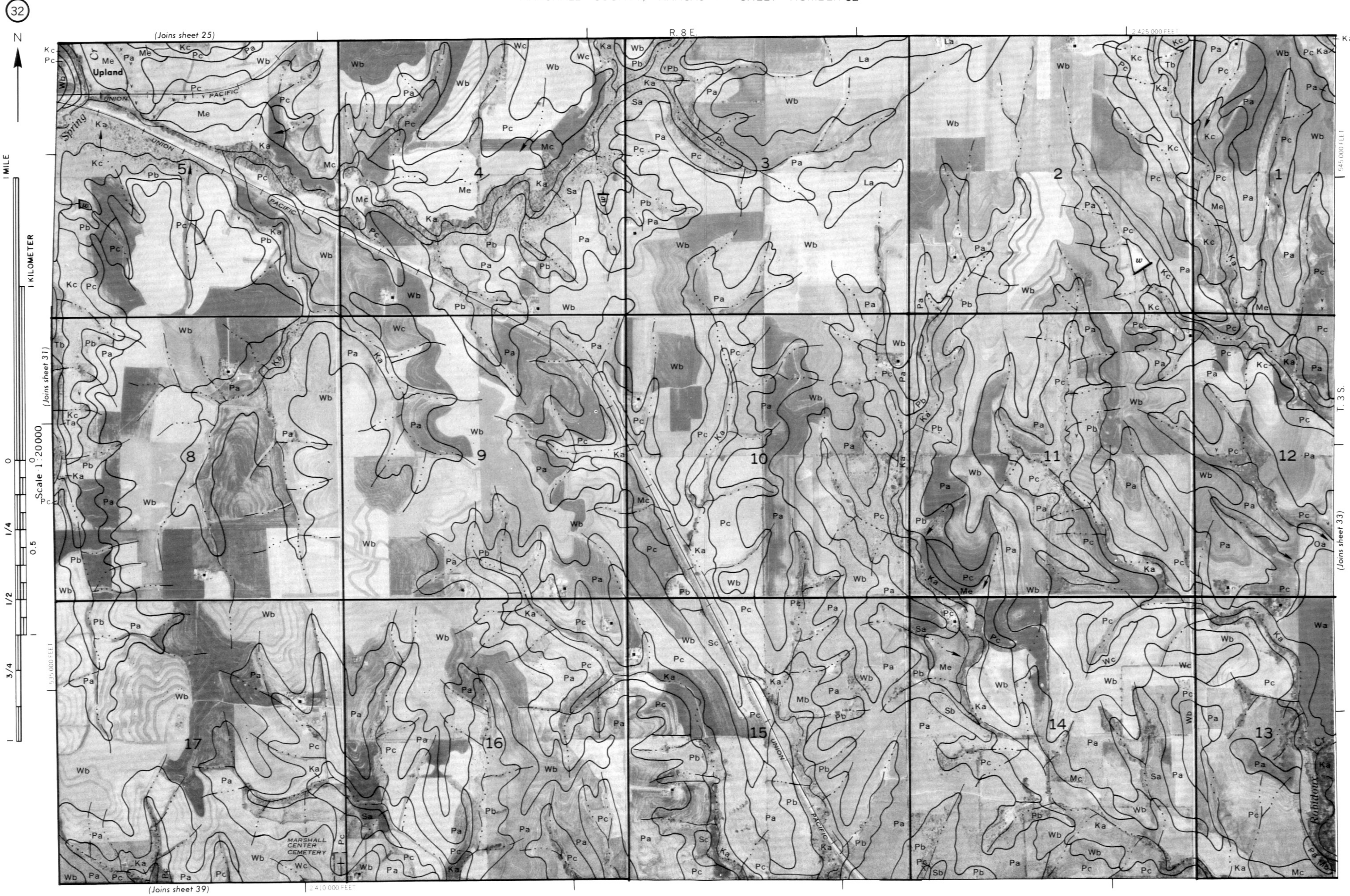

27
N
(Joins sheet 20)
(Joins sheet 28)
(Joins sheet 26)
(Joins sheet 34)
R. 9 E.
R. 10 E.
T. 2 S.
2 455 000 FEET
2 475 000 FEET
550 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33
Snipe Creek
water

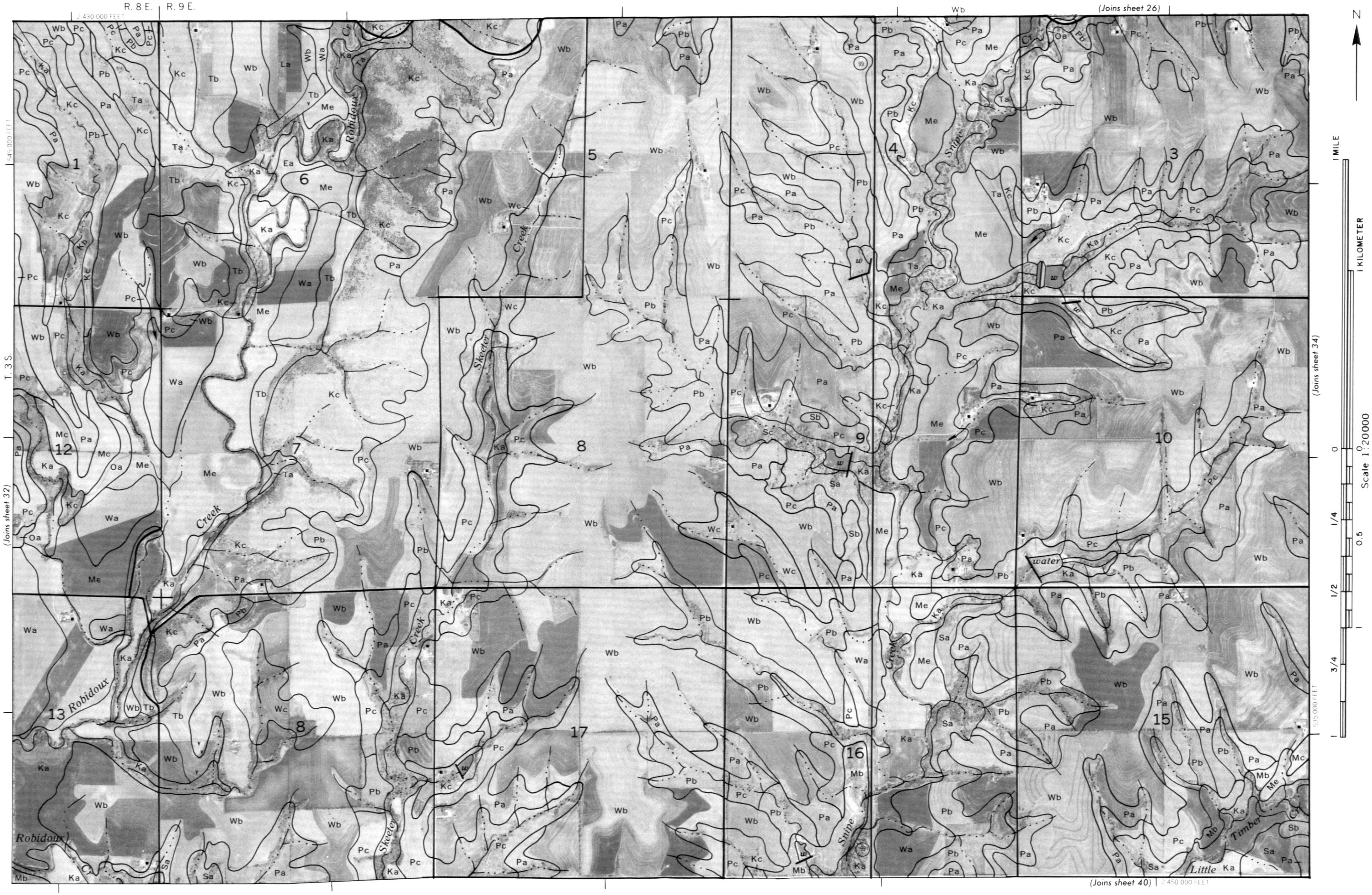

28
N
(Joins sheet 21)
R. 10 E.
2 495 000 FEET
Axtell
UNION
PACIFIC
T. 2 S.
NEMAHA COUNTY
(Joins sheet 27)
(Joins sheet 35)
2 480 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
21
22
23
24
25
26
27
28
33
34
35
36

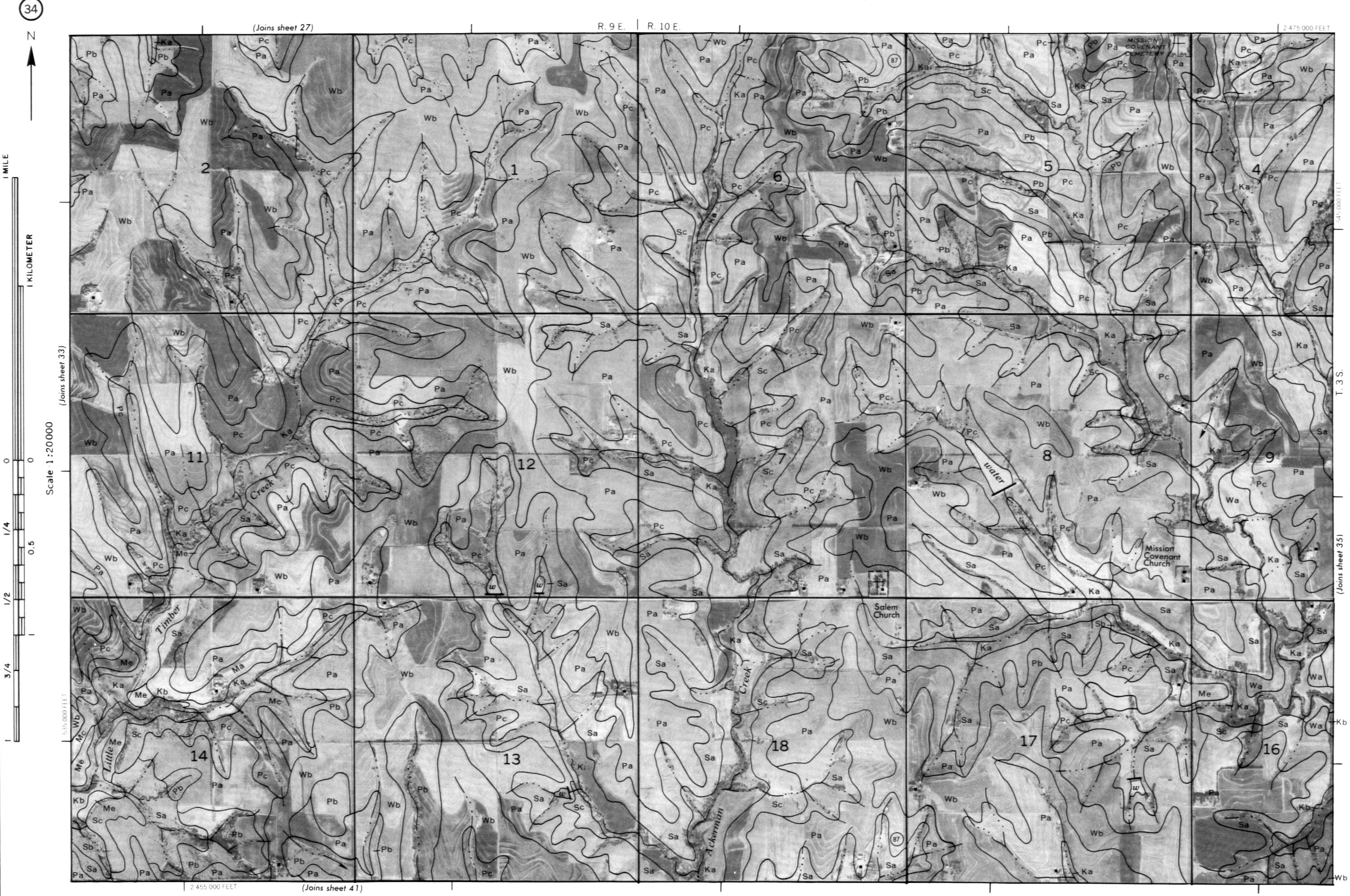

R. 6 E.
2 340 000 FEET
(Joins sheet 22)
(Joins sheet 30)
(Joins sheet 36)
2 355 000 FEET
T. 3 S.
WASHINGTON COUNTY
EVERGREEN CEMETERY
Afton Trinity Church
Walnut Creek
Walnut
Creek
East Fork Walnut
Cr.
6
5
4
3
2
7
8
9
10
11
18
17
16
15
14
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5

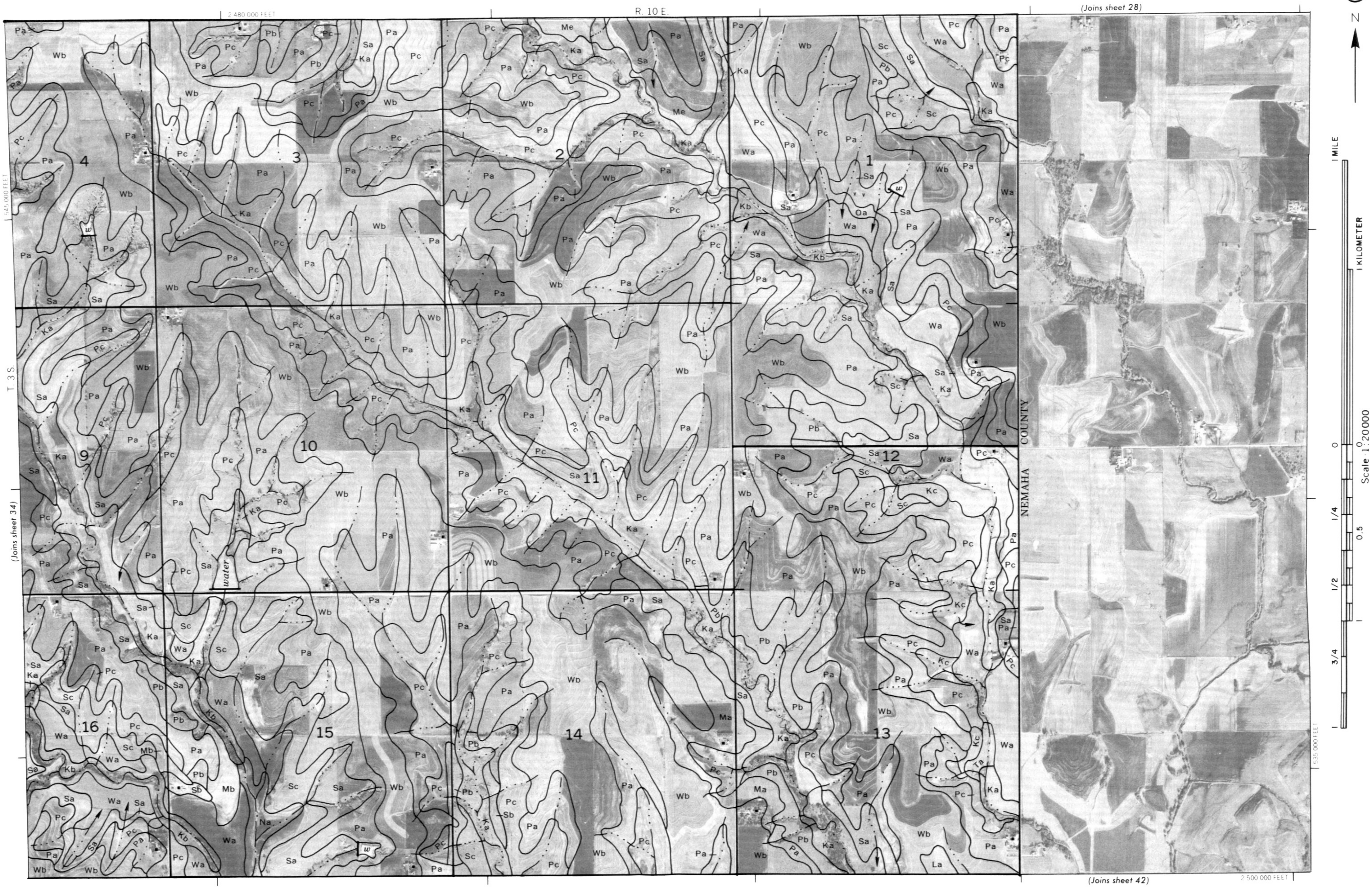

30
N
(Joins sheet 23)
R. 6 E.
R. 7 E.
2 380 000 FEET
545 000 FEET
(Joins sheet 29)
(Joins sheet 31)
T. 3 S.
535 000 FEET
2 360 000 FEET
(Joins sheet 37)
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
Hop Creek
Dutch Creek
BIG BLUE RIVER
UNION PACIFIC
77
water
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18


(Joins sheet 24)
(Joins sheet 30)
(Joins sheet 32)
(Joins sheet 38)
R. 7 E.
R. 8 E.
T. 3 S.
2 385 000 FEET
2 405 000 FEET
545 000 FEET
535 000 FEET
N
UNION PACIFIC
Spring Creek
Spring Cr
Lily Cr
Schell Creek
1
2
3
6
7
10
11
12
13
14
15
18
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1

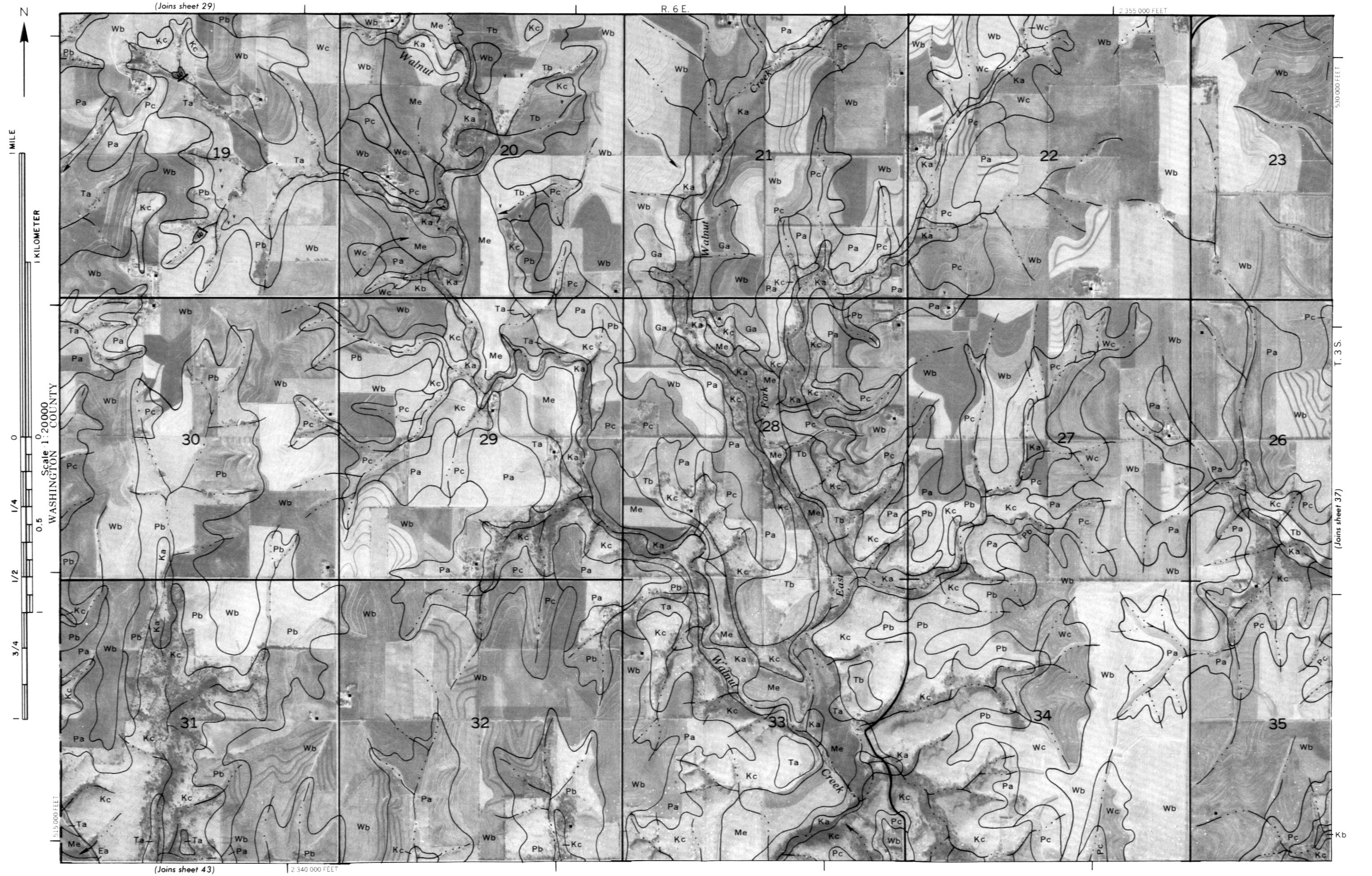

32
N
(Joins sheet 25)
(Joins sheet 31)
(Joins sheet 33)
(Joins sheet 39)
R. 8 E.
T. 3 S.
2 425 000 FEET
545 000 FEET
2 410 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
Spring Cr
Upland
UNION PACIFIC
MARSHALL CENTER CEMETERY
Robidoux Cr
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17

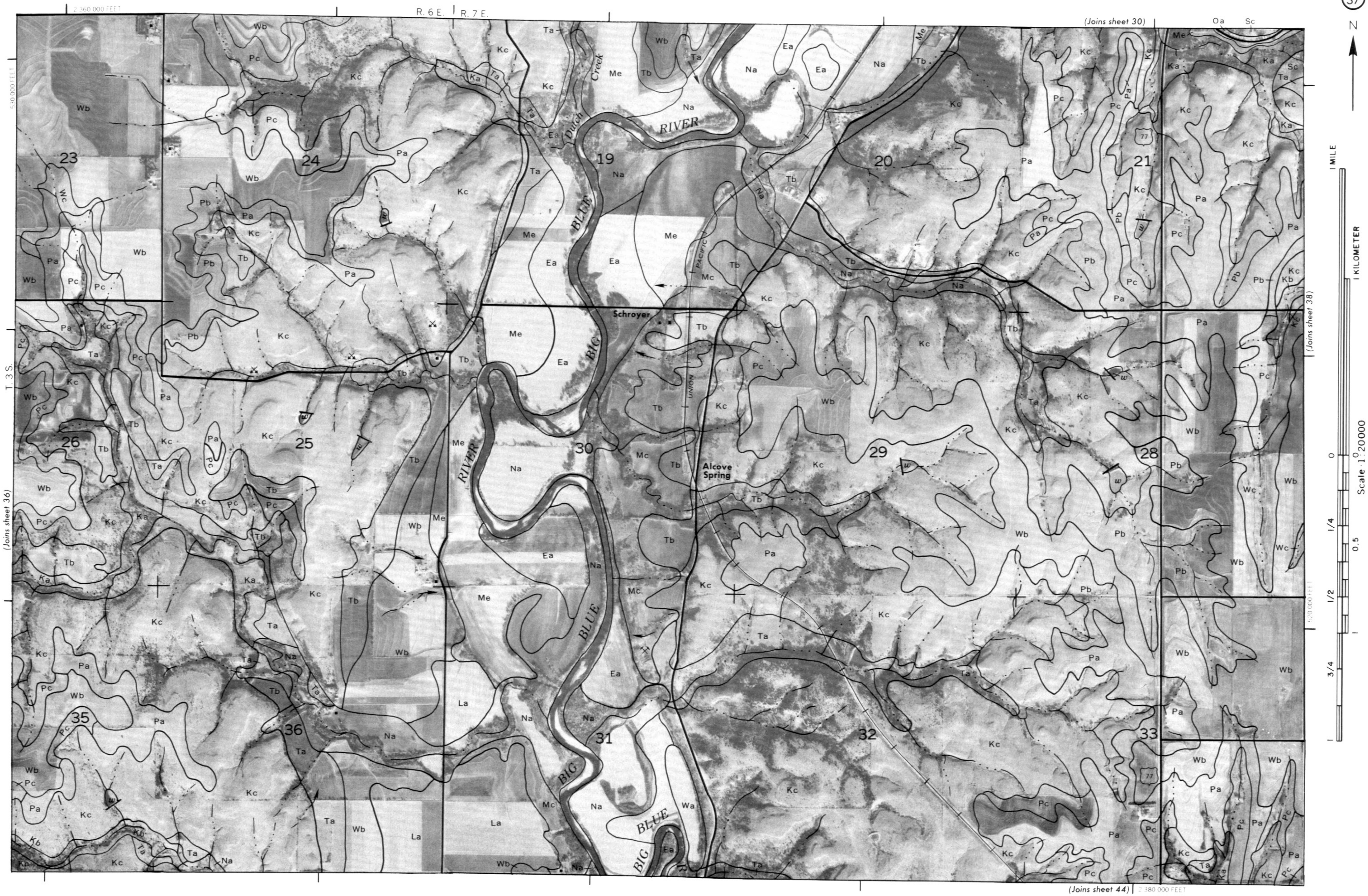

R. 8 E.
R. 9 E.
T. 3 S.
2 430 000 FEET
545 000 FEET
2 450 000 FEET
(Joins sheet 26)
(Joins sheet 34)
(Joins sheet 32)
(Joins sheet 40)
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
Robidoux
Creek
Skeeter
Snipe
Little Timber Cr
water
1
3
4
5
6
7
8
9
10
12
13
15
16
17


34
N
(Joins sheet 27)
R. 9 E.
R. 10 E.
2 475 000 FEET
(Joins sheet 33)
(Joins sheet 35)
(Joins sheet 41)
2 455 000 FEET
545 000 FEET
535 000 FEET
T. 3 S.
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
MISSION COVENANT CEMETERY
Mission Covenant Church
Salem Church
Timber Creek
Little
Ackerman Creek
water
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18


(Joins sheet 28)
2 480 000 FEET
R. 10 E.
T. 3 S.
(Joins sheet 34)
NEMAHA COUNTY
(Joins sheet 42)
2 500 000 FEET
545 000 FEET
535 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
water
1
2
3
4
9
10
11
12
13
14
15
16

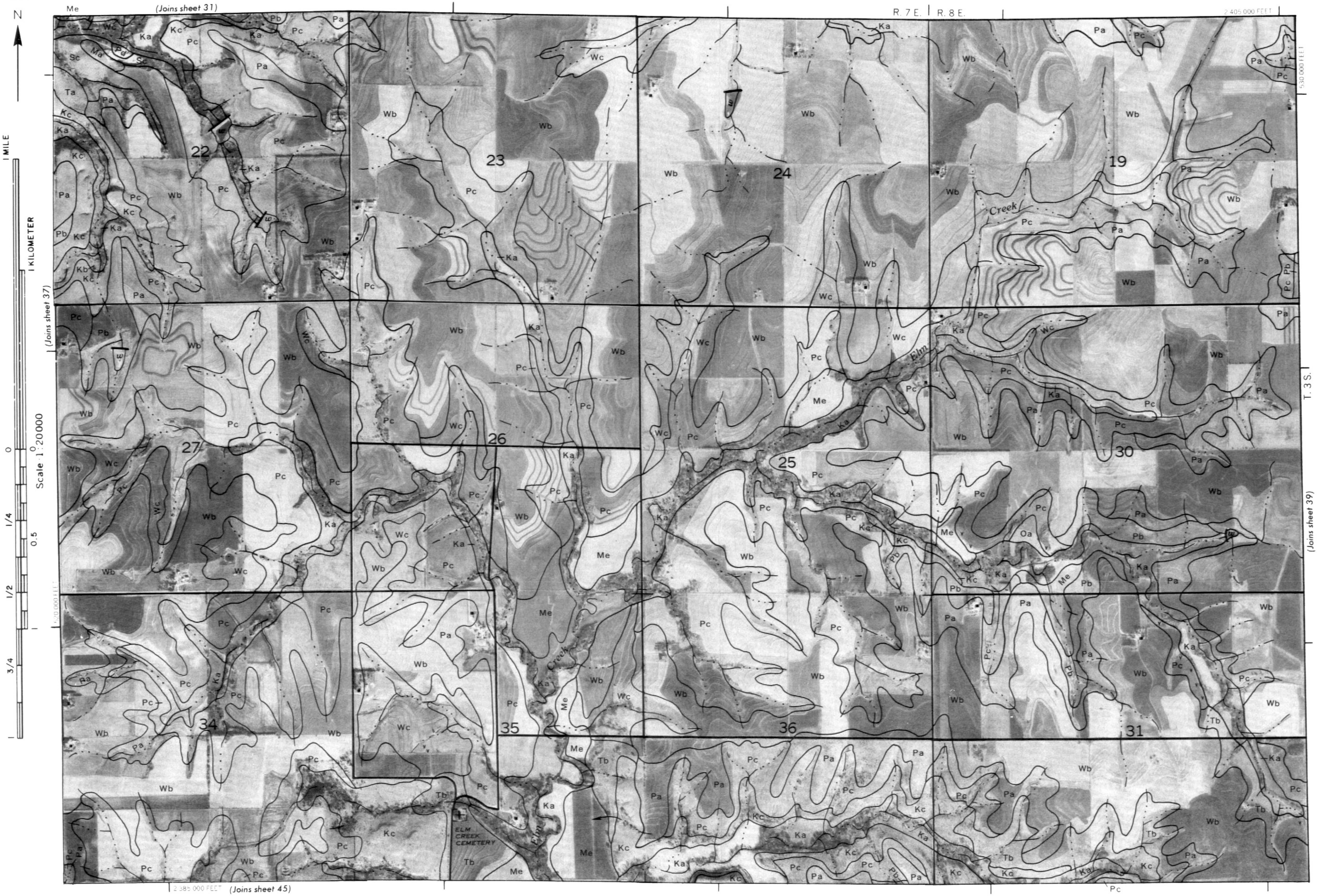
MARSHALL COUNTY, KANSAS — SHEET NUMBER 36

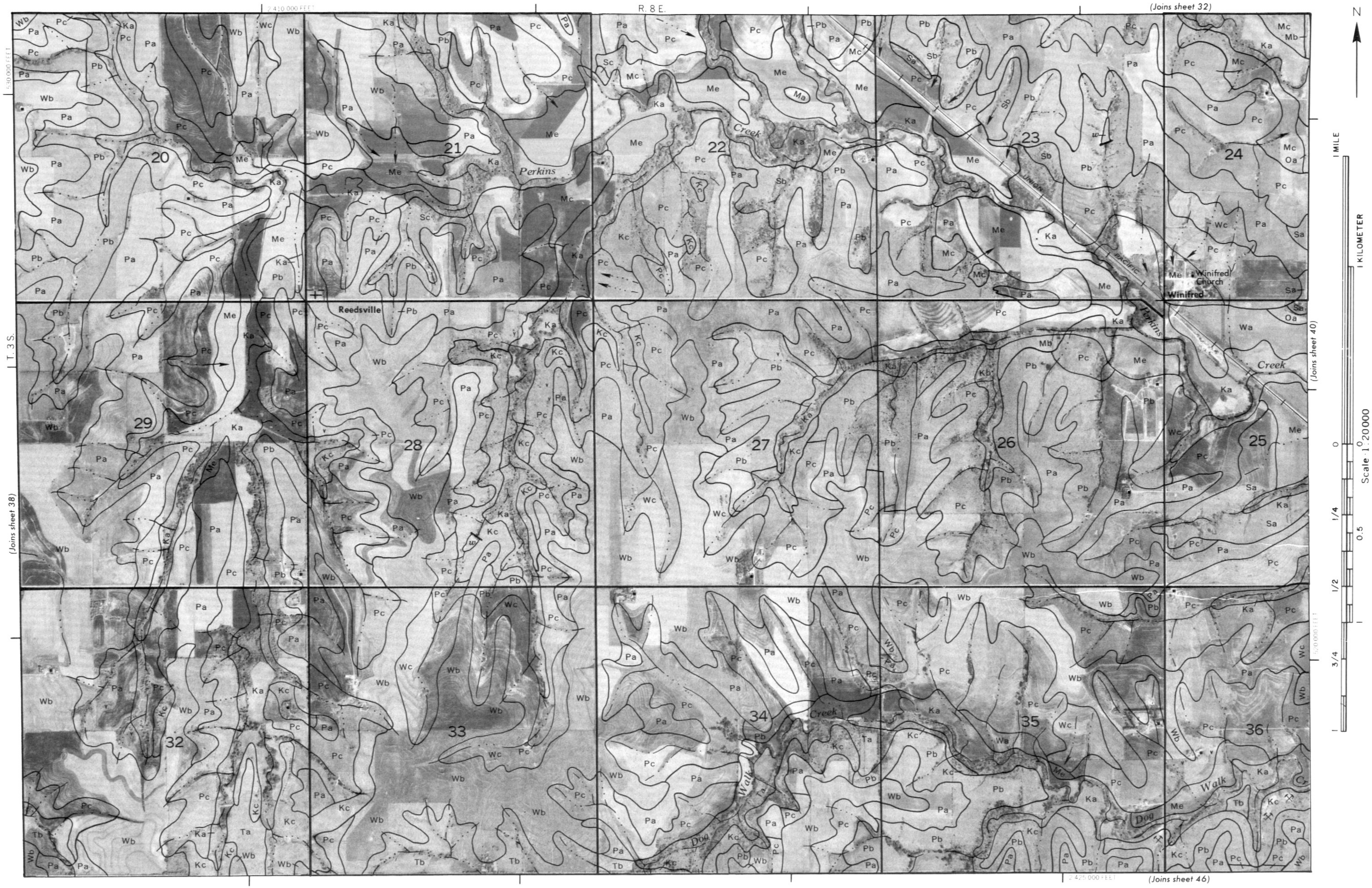


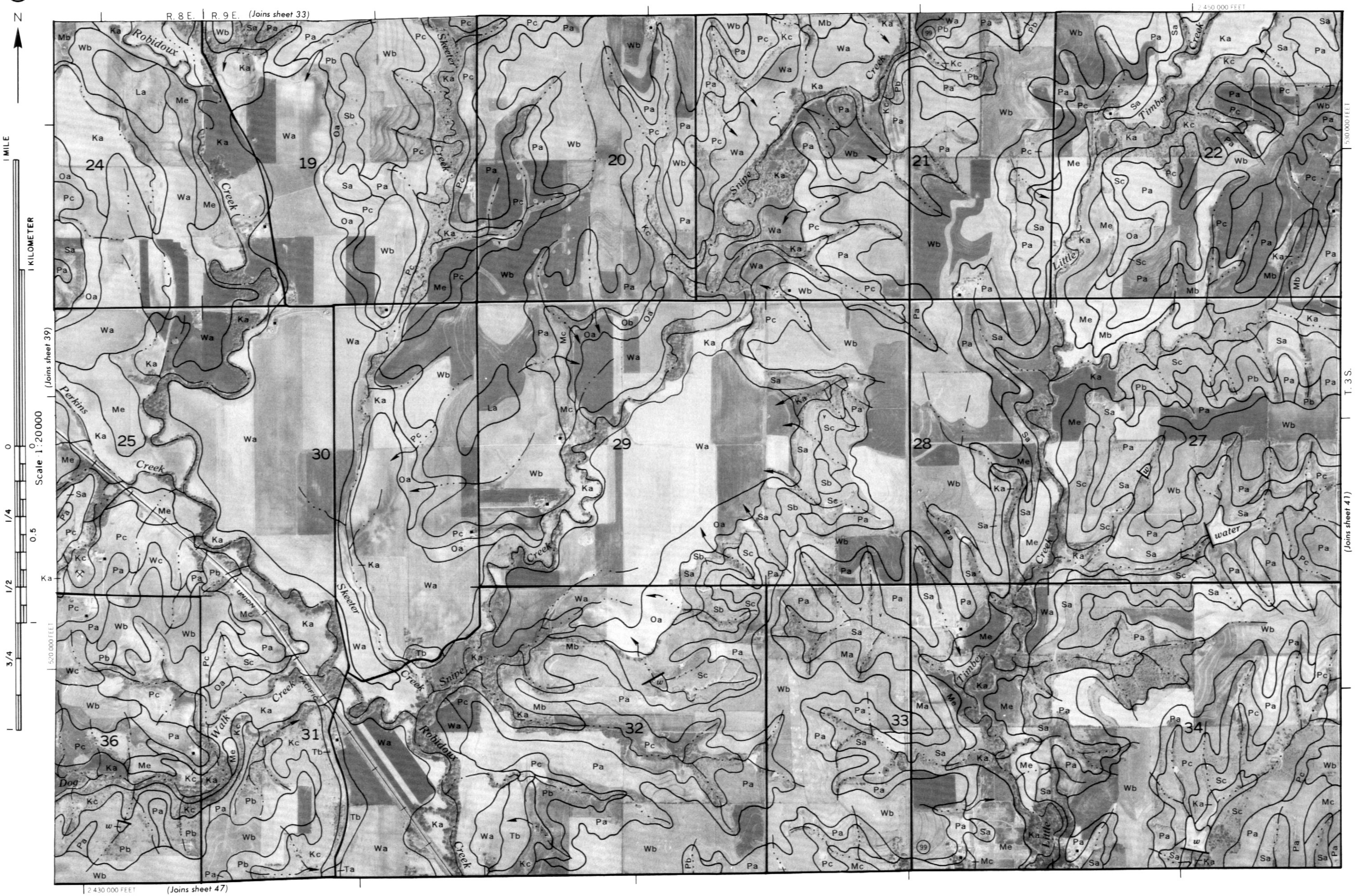


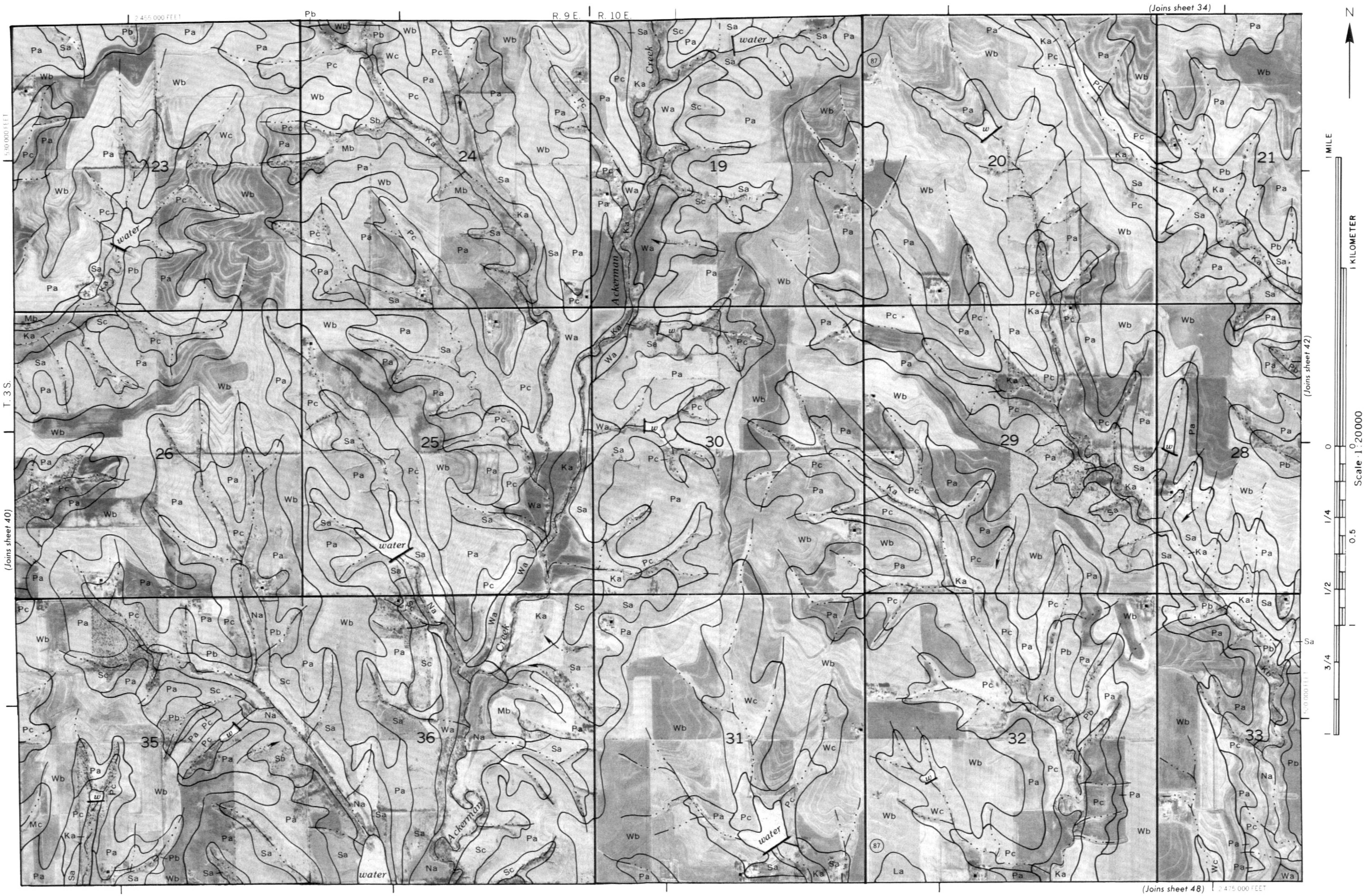
2 360 000 FEET
R. 6 E.
R. 7 E.
(Joins sheet 30)
(Joins sheet 38)
(Joins sheet 36)
(Joins sheet 44)
2 380 000 FEET
T. 3 S.
N
Dutch Creek
BIG BLUE RIVER
UNION PACIFIC
Schroyer
Alcove Spring
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5

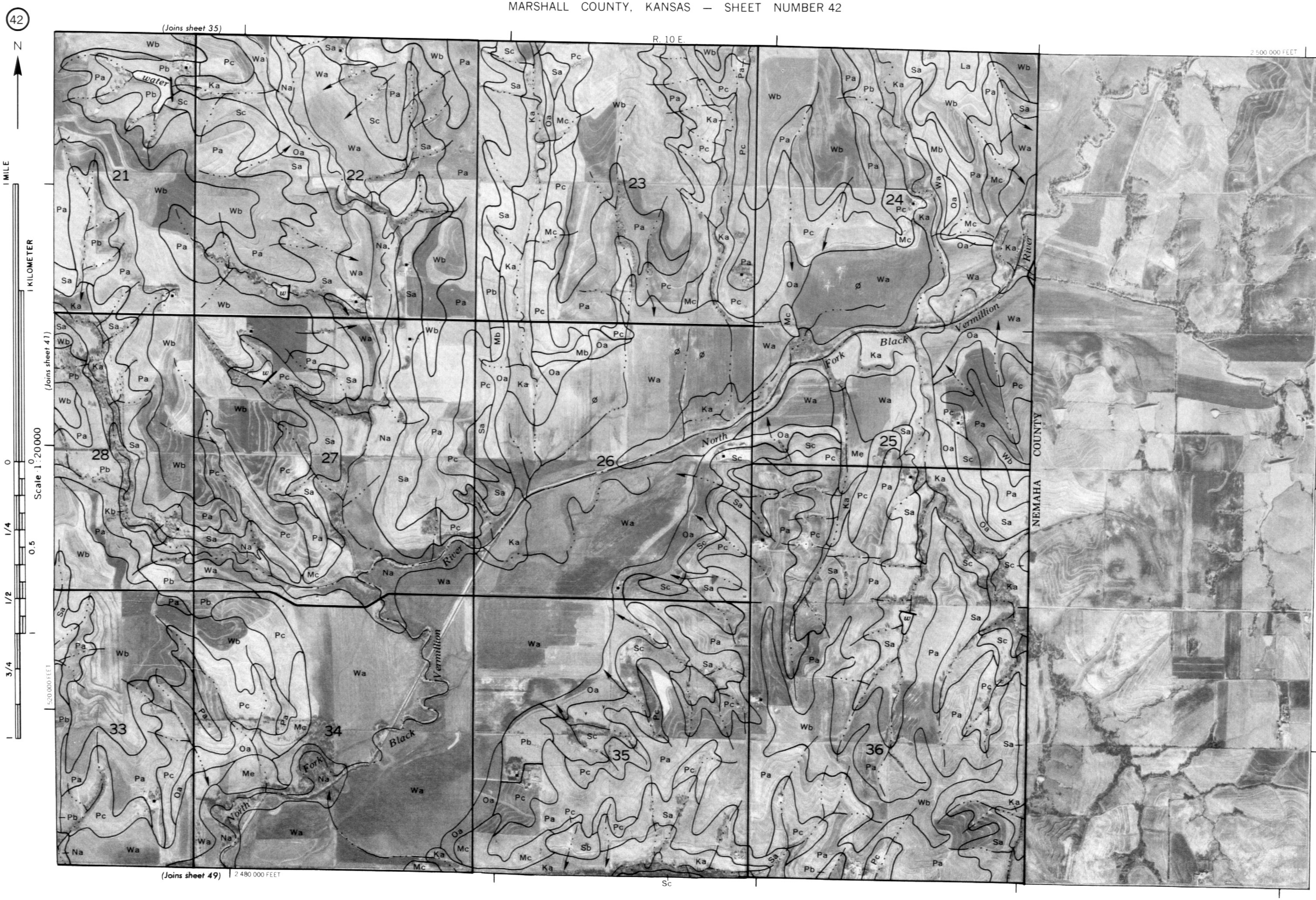
MARSHALL COUNTY, KANSAS — SHEET NUMBER 38



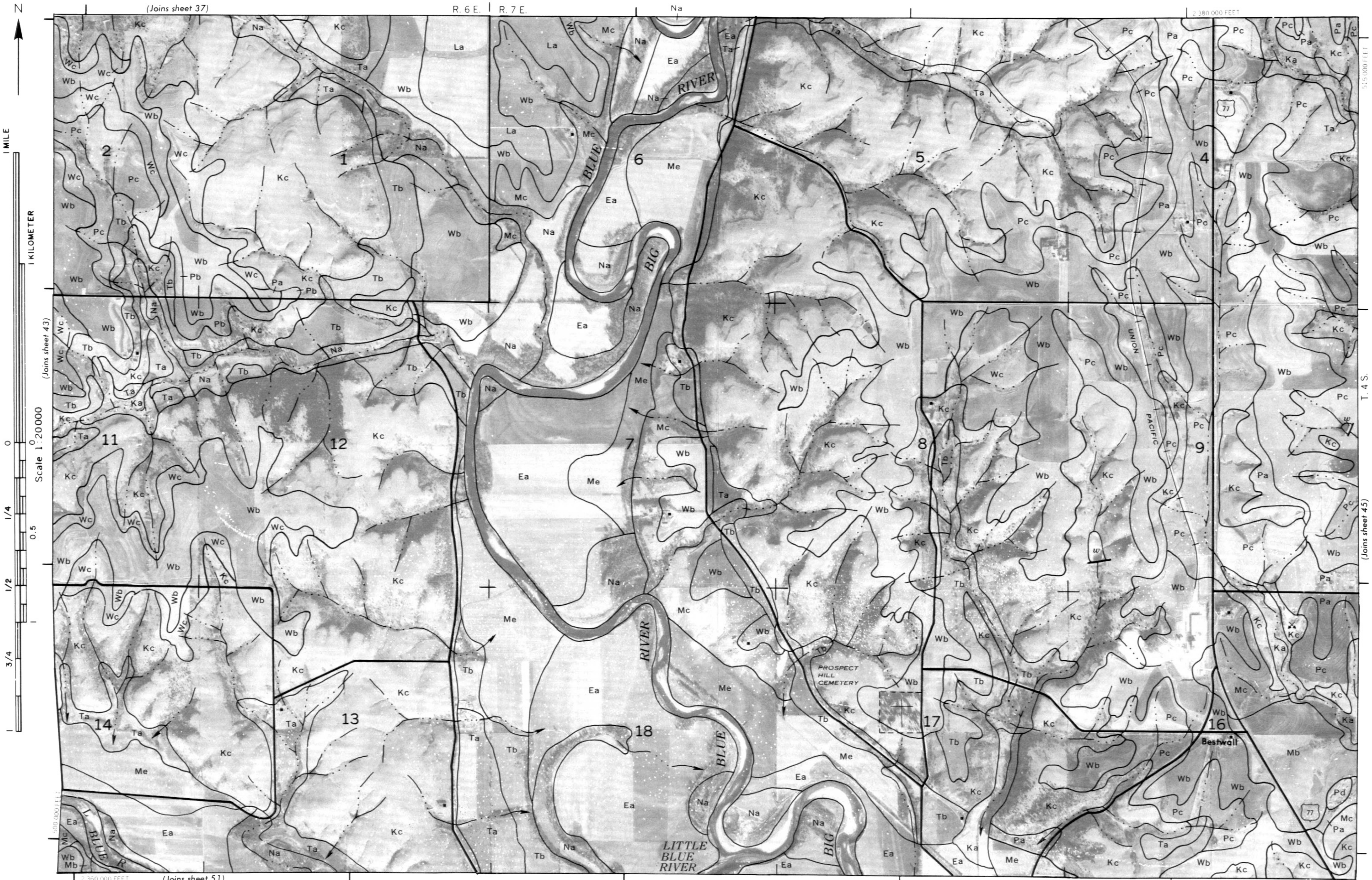

R. 8 E.
T. 3 S.
(Joins sheet 32)
(Joins sheet 40)
(Joins sheet 38)
(Joins sheet 46)
2 410 000 FEET
2 425 000 FEET
N
Reedsville
Winifred
Winifred Church
Perkins Creek
Dog Walk Creek
UNION PACIFIC
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

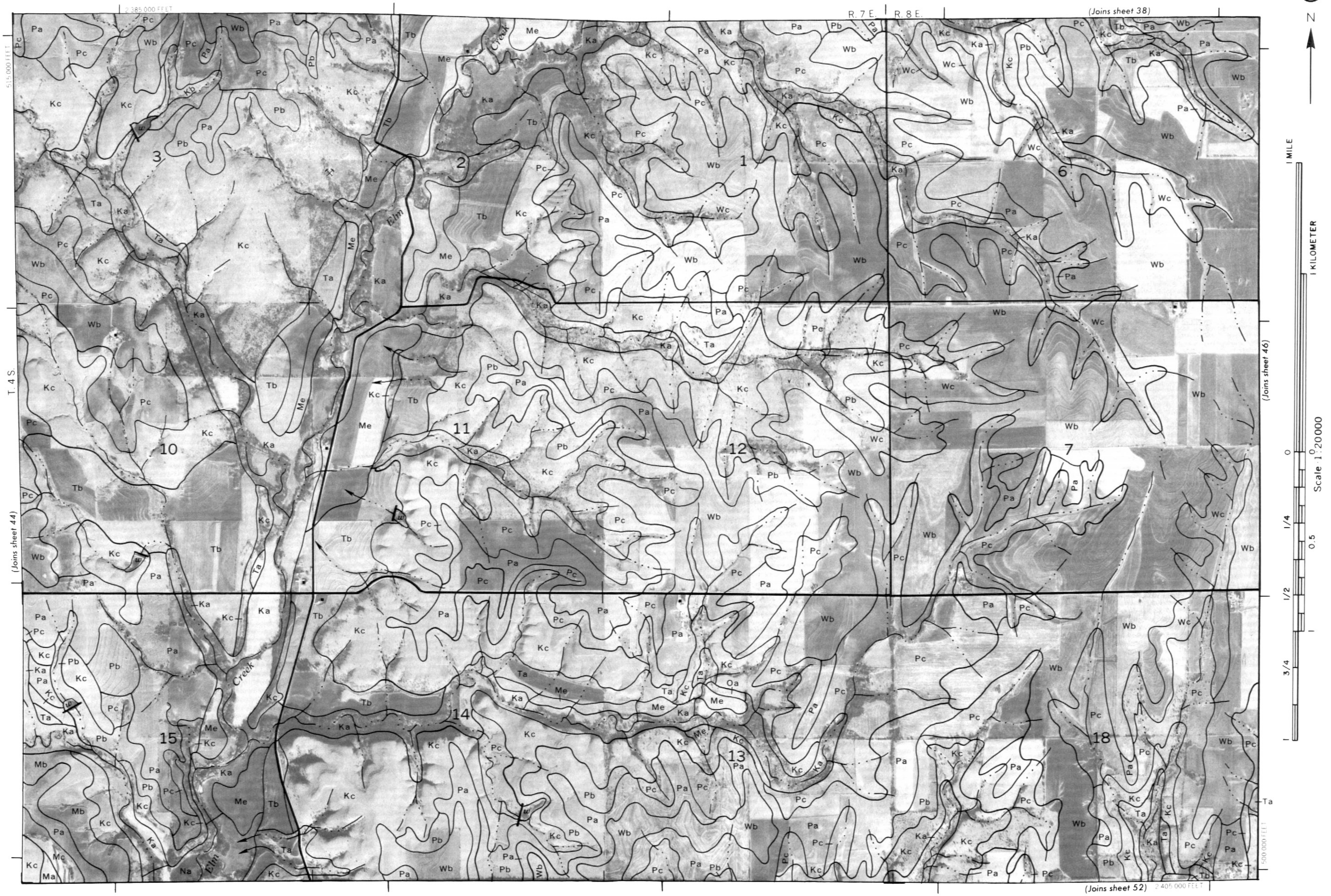

40
N
R. 8 E.
R. 9 E.
(Joins sheet 33)
2 450 000 FEET
530 000 FEET
T. 3 S.
(Joins sheet 41)
(Joins sheet 39)
(Joins sheet 47)
2 430 000 FEET
520 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36
Robidoux Creek
Skeeter Creek
Snipe Creek
Timber Creek
Little Timber Creek
Perkins Creek
Walk Creek
Dog Creek
UNION PACIFIC
water
99

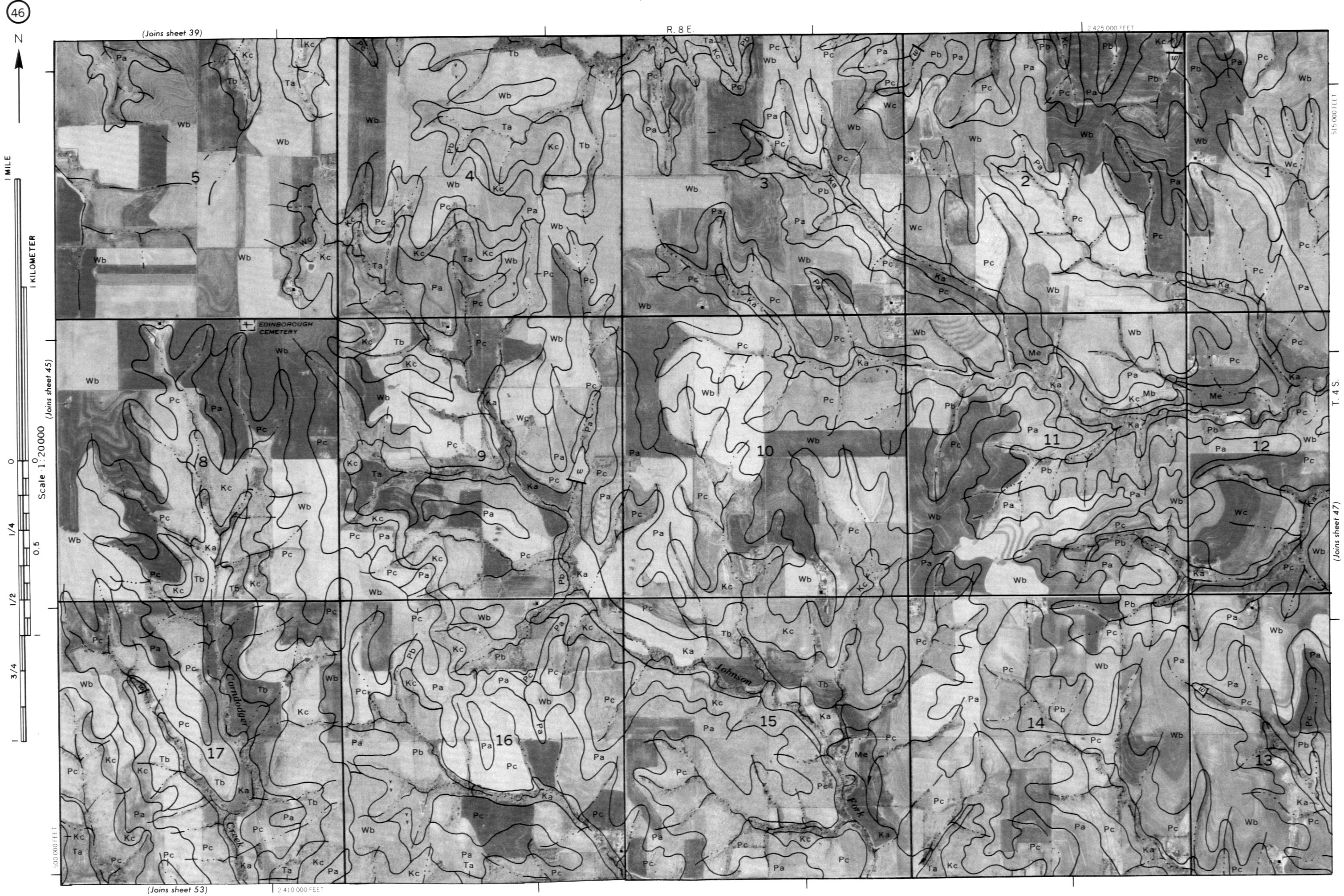

(Joins sheet 34)
(Joins sheet 40)
(Joins sheet 42)
(Joins sheet 48)
R. 9 E.
R. 10 E.
T. 3 S.
2 455 000 FEET
2 475 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
Ackerman Creek
Creek
Ackerman
water
87
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36


N
(Joins sheet 35)
R. 10 E.
2 500 000 FEET
(Joins sheet 41)
(Joins sheet 49)
2 480 000 FEET
530 000 FEET
520 000 FEET
T. 3 S.
NEMAHA COUNTY
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
21
22
23
24
25
26
27
28
33
34
35
36
North Fork Black Vermillion River
water

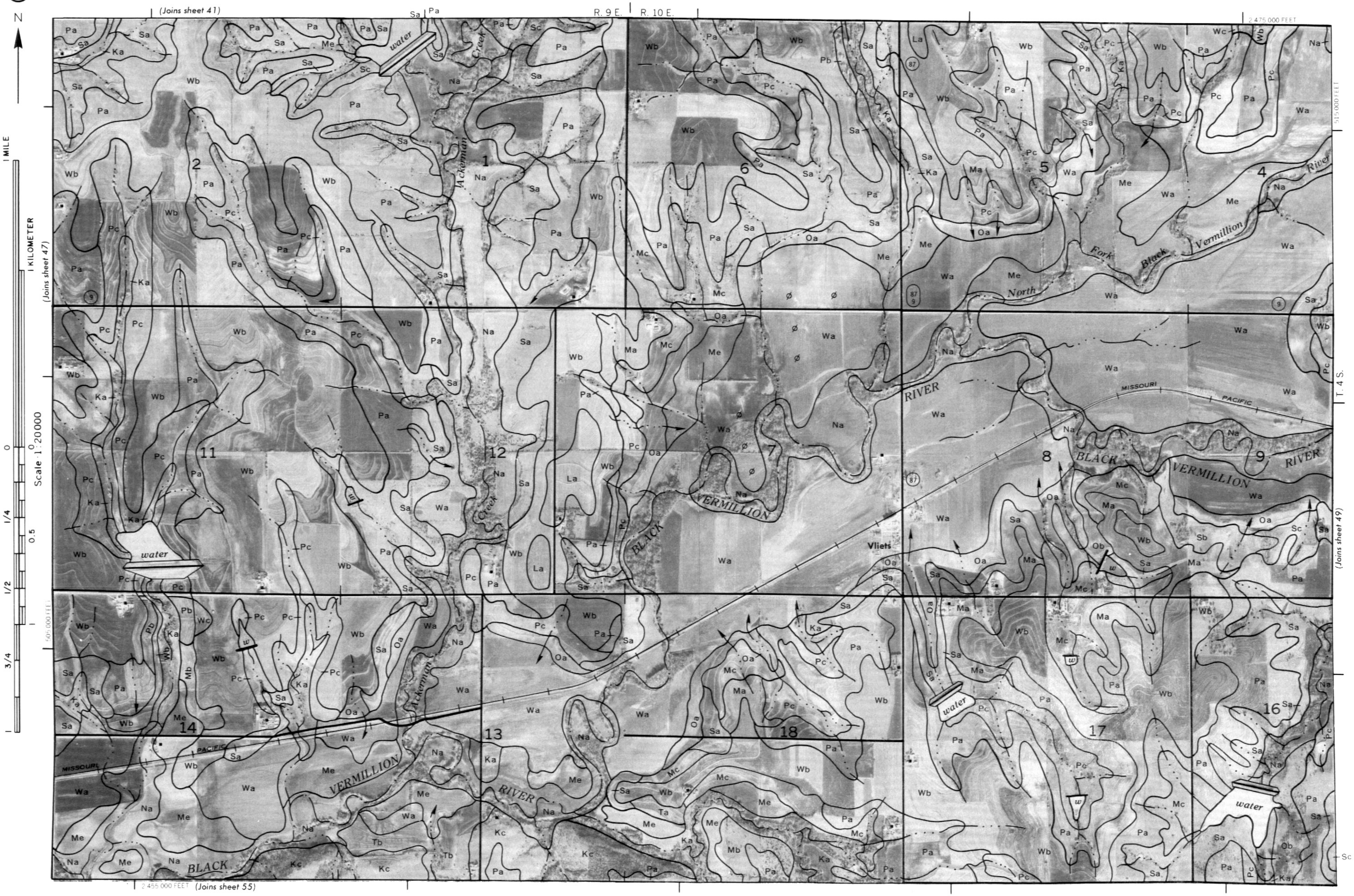

(Joins sheet 36)
R. 6 E.
2 340 000 FEET
510 000 FEET
T. 4 S.
WASHINGTON COUNTY
KEEFOVER CEMETERY
Walnut Creek
LITTLE BLUE RIVER
MISSOURI PACIFIC
Lake Idlewild
BLUE RIVER
LITTLE
RIVERSIDE CEMETERY
(Joins sheet 44)
(Joins sheet 50)
2 355 000 FEET
500 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000

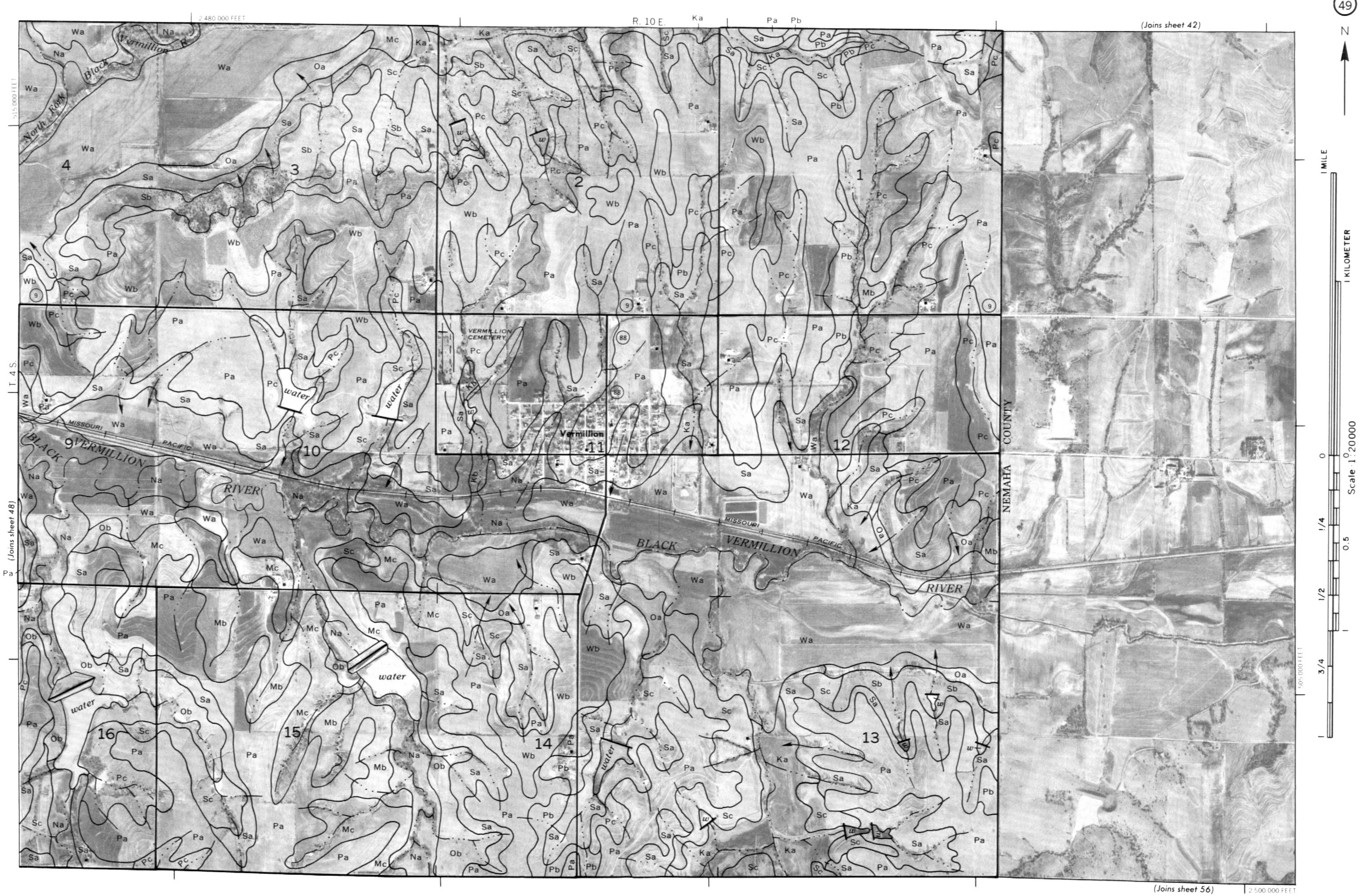

N
(Joins sheet 37)
R. 6 E.
R. 7 E.
2 380 000 FEET
(Joins sheet 43)
(Joins sheet 45)
(Joins sheet 51)
2 360 000 FEET
T. 4 S.
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
BIG BLUE RIVER
LITTLE BLUE RIVER
L. BLUE R.
UNION PACIFIC
PROSPECT HILL CEMETERY
Bestwall
77
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18

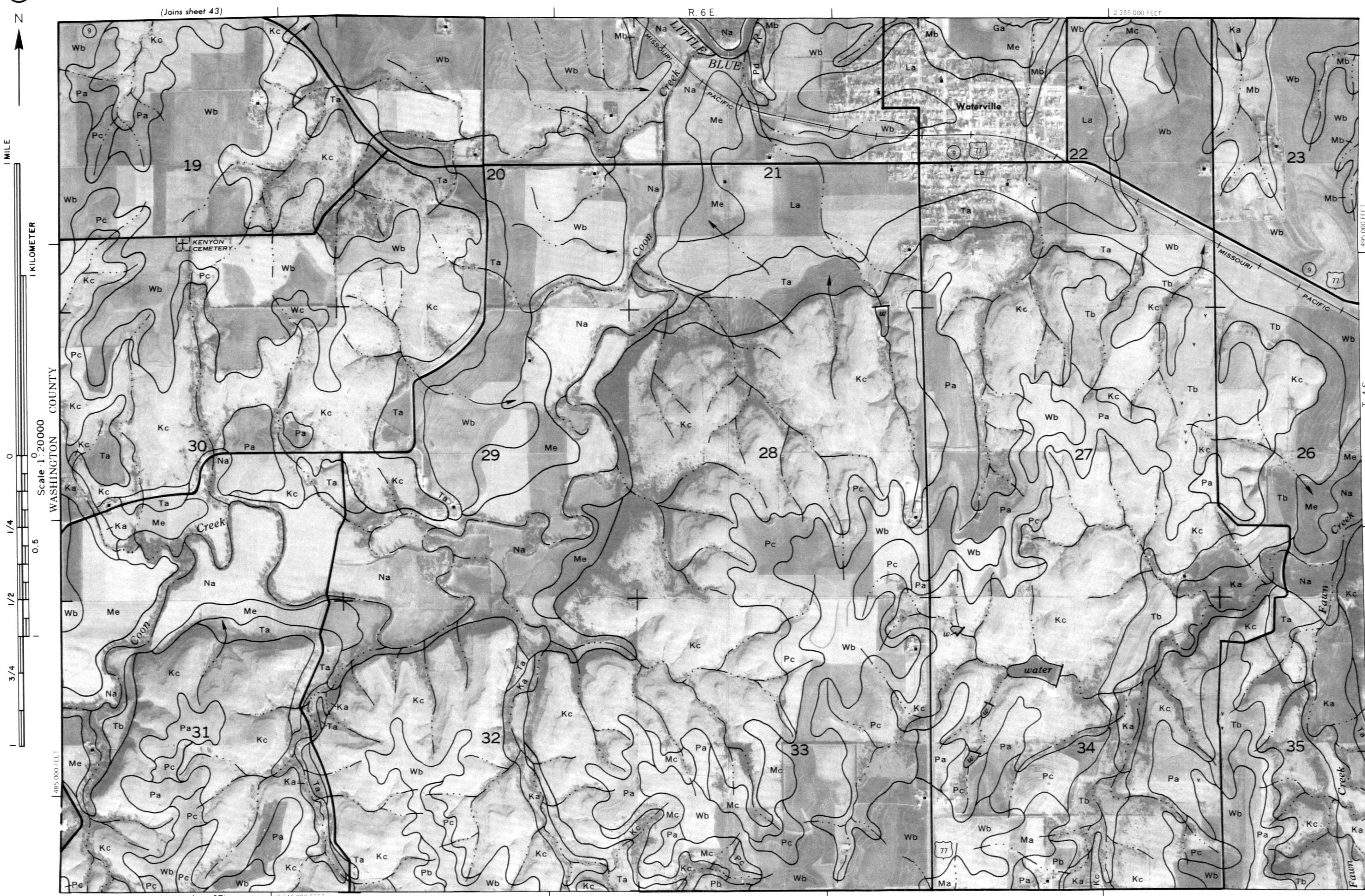

(Joins sheet 38)
(Joins sheet 44)
(Joins sheet 46)
(Joins sheet 52)
R. 7 E.
R. 8 E.
T. 4 S.
2 385 000 FEET
2 405 000 FEET
515 000 FEET
500 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
Elm
Creek
1
2
3
6
7
10
11
12
13
14
15
18

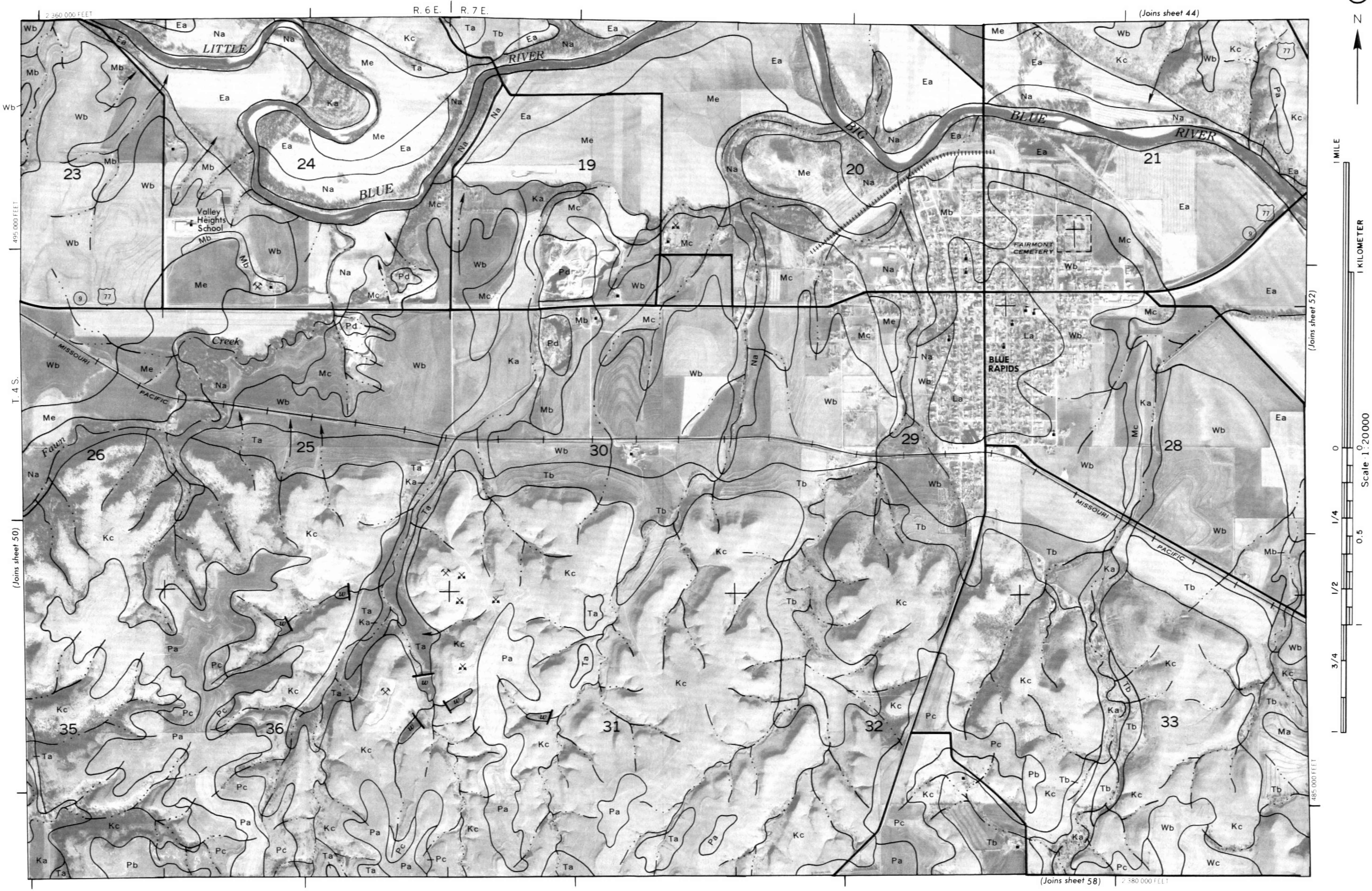

46
N
(Joins sheet 39)
R. 8 E.
2 425 000 FEET
515 000 FEET
T. 4 S.
(Joins sheet 45)
(Joins sheet 47)
(Joins sheet 53)
2 410 000 FEET
500 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
EDINBOROUGH CEMETERY
Corndodger
Creek
Johnson
Fork
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17


(Joins sheet 40)
(Joins sheet 46)
(Joins sheet 48)
(Joins sheet 54)
R. 8 E.
R. 9 E.
T. 4 S.
2 430 000 FEET
2 450 000 FEET
515 000 FEET
505 000 FEET
N
Scale 1:20000
1 MILE
1 KILOMETER
Frankfort
CALVARY CEMETERY
FRANKFORT CEMETERY
UNION PACIFIC
MISSOURI PACIFIC
BLACK VERMILLION RIVER
Robidoux Creek
Timber Creek
Little Timber Creek
Little
water


(Joins sheet 41)
R. 9 E.
R. 10 E.
2 475 000 FEET
515 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
0.5
1/2
3/4
1
(Joins sheet 47)
(Joins sheet 49)
T. 4 S.
505 000 FEET
2 455 000 FEET
(Joins sheet 55)
Ackerman Creek
North Fork Black Vermillion River
BLACK VERMILLION RIVER
MISSOURI PACIFIC
Vliets
water
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18

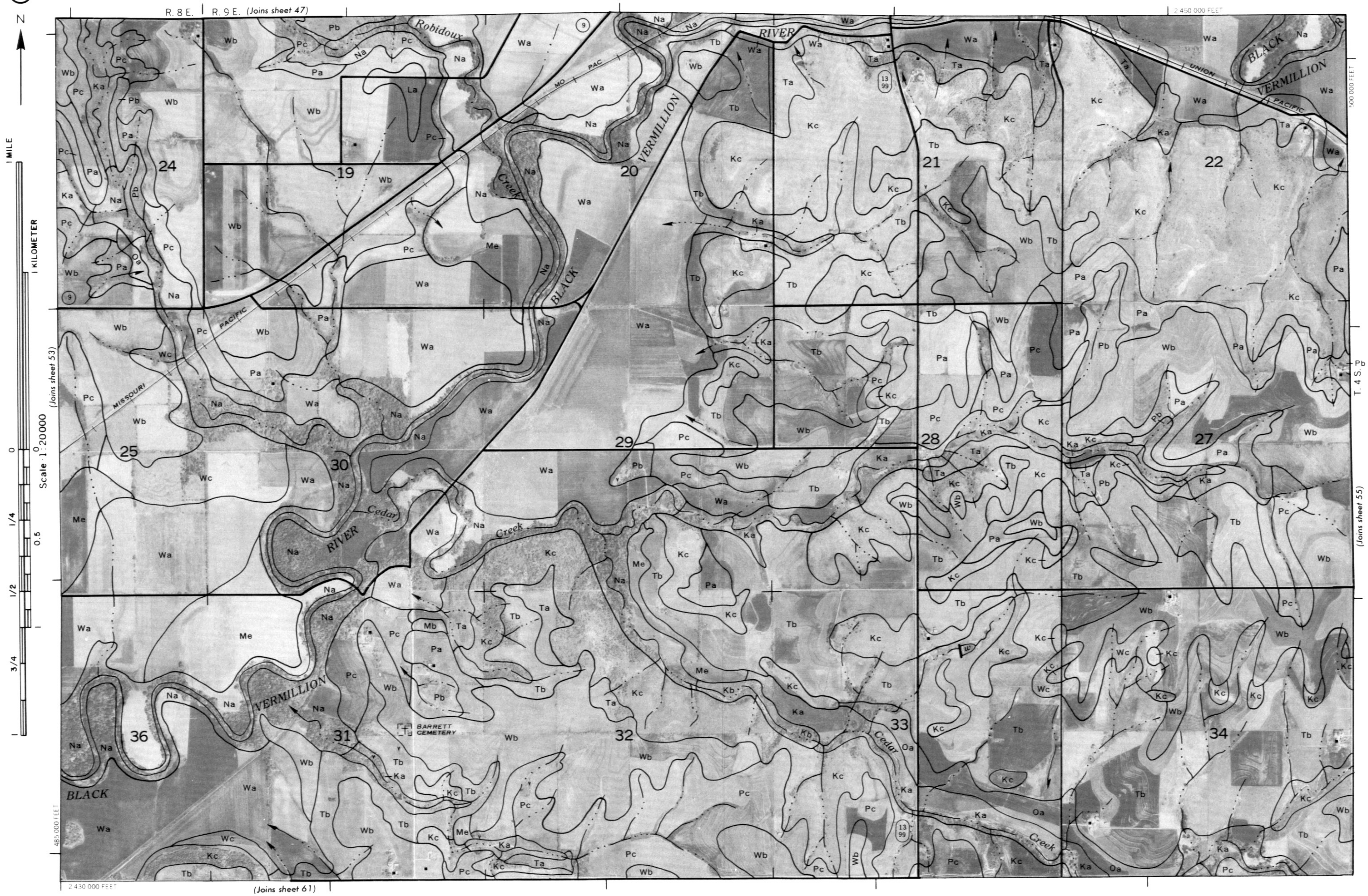

49
N
(Joins sheet 42)
(Joins sheet 48)
(Joins sheet 56)
2 480 000 FEET
2 500 000 FEET
R. 10 E.
T. 4 S.
North Fork Black Vermillion R.
VERMILLION CEMETERY
Vermillion
BLACK VERMILLION RIVER
MISSOURI PACIFIC
NEMAHA COUNTY
water
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5

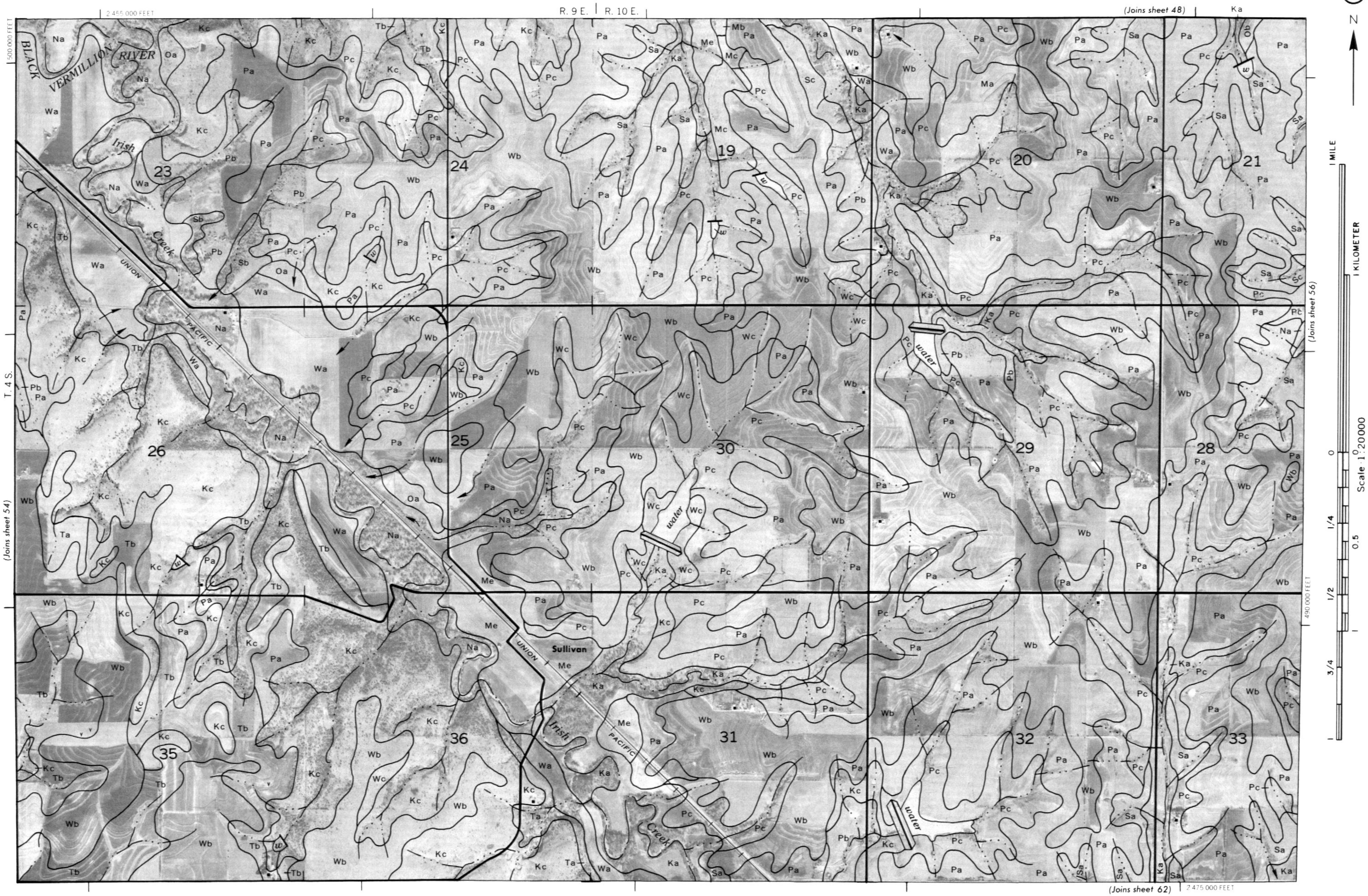

N
(Joins sheet 43)
R. 6 E.
2 355 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
0.5
1/2
3/4
1
WASHINGTON COUNTY
LITTLE BLUE R
Waterville
MISSOURI PACIFIC
Coon Creek
Creek
Faun Creek
KENYON CEMETERY
water
495 000 FEET
T. 4 S.
(Joins sheet 51)
485 000 FEET
2 340 000 FEET
(Joins sheet 57)
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35


51
N
R. 6 E.
R. 7 E.
2 360 000 FEET
(Joins sheet 44)
(Joins sheet 50)
(Joins sheet 52)
(Joins sheet 58)
2 380 000 FEET
495 000 FEET
485 000 FEET
T. 4 S.
LITTLE
BLUE
RIVER
BIG
BLUE
RIVER
Valley Heights School
Creek
Fawn
MISSOURI
PACIFIC
FAIRMONT CEMETERY
BLUE RAPIDS
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33
1 MILE
1 KILOMETER
Scale 1:20 000
0
1/4
1/2
3/4
0.5

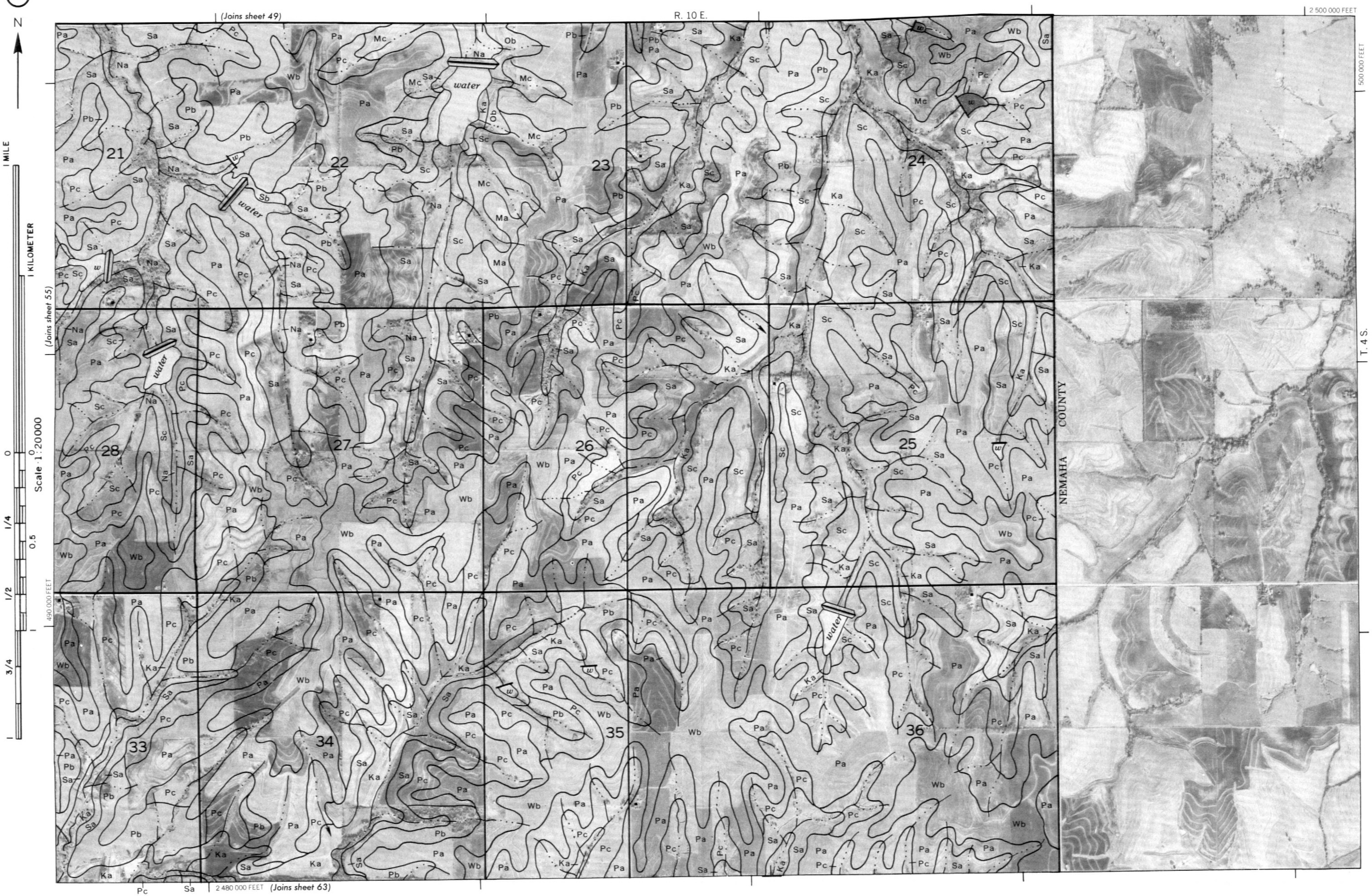

N
(Joins sheet 45)
(Joins sheet 51)
(Joins sheet 53)
(Joins sheet 59)
R. 7 E.
R. 8 E.
T. 4 S.
2 405 000 FEET
495 000 FEET
485 000 FEET
2 385 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
Elm
Creek
BIG
BLUE
RIVER
BIG BLUE R
MISSOURI
PACIFIC
22
23
24
19
27
26
25
30
34
35
36
31
77
9

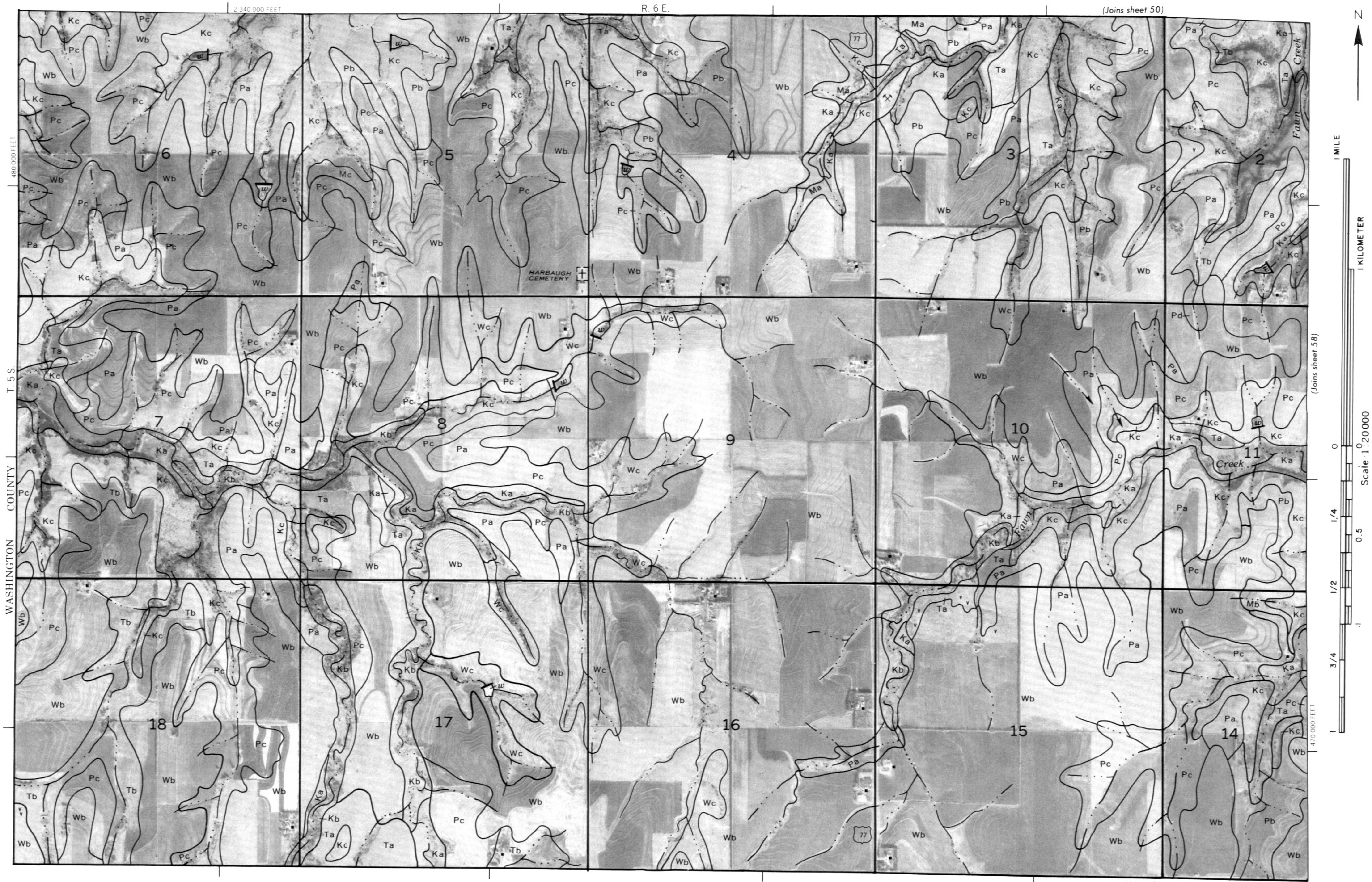

(Joins sheet 46)
R. 8 E.
2 410 000 FEET
495 000 FEET
T. 4 S.
(Joins sheet 52)
(Joins sheet 54)
(Joins sheet 60)
Na
485 000 FEET
2 430 000 FEET
N
Corndodger Creek
Johnson Fork
Johnson
Corndodger Creek
MISSOURI PACIFIC
BLACK VERMILLION R
20
21
22
23
24
29
28
27
26
25
32
33
34
35
36
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1


R. 8 E.
R. 9 E. (Joins sheet 47)
(Joins sheet 53)
(Joins sheet 55)
(Joins sheet 61)
T. 4 S.
N
1 MILE
1 KILOMETER
Scale 1:20000
2 450 000 FEET
500 000 FEET
485 000 FEET
2 430 000 FEET
Robidoux
BLACK VERMILLION RIVER
Cedar Creek
MO PAC
MISSOURI PACIFIC
UNION PACIFIC
BARRETT CEMETERY
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36

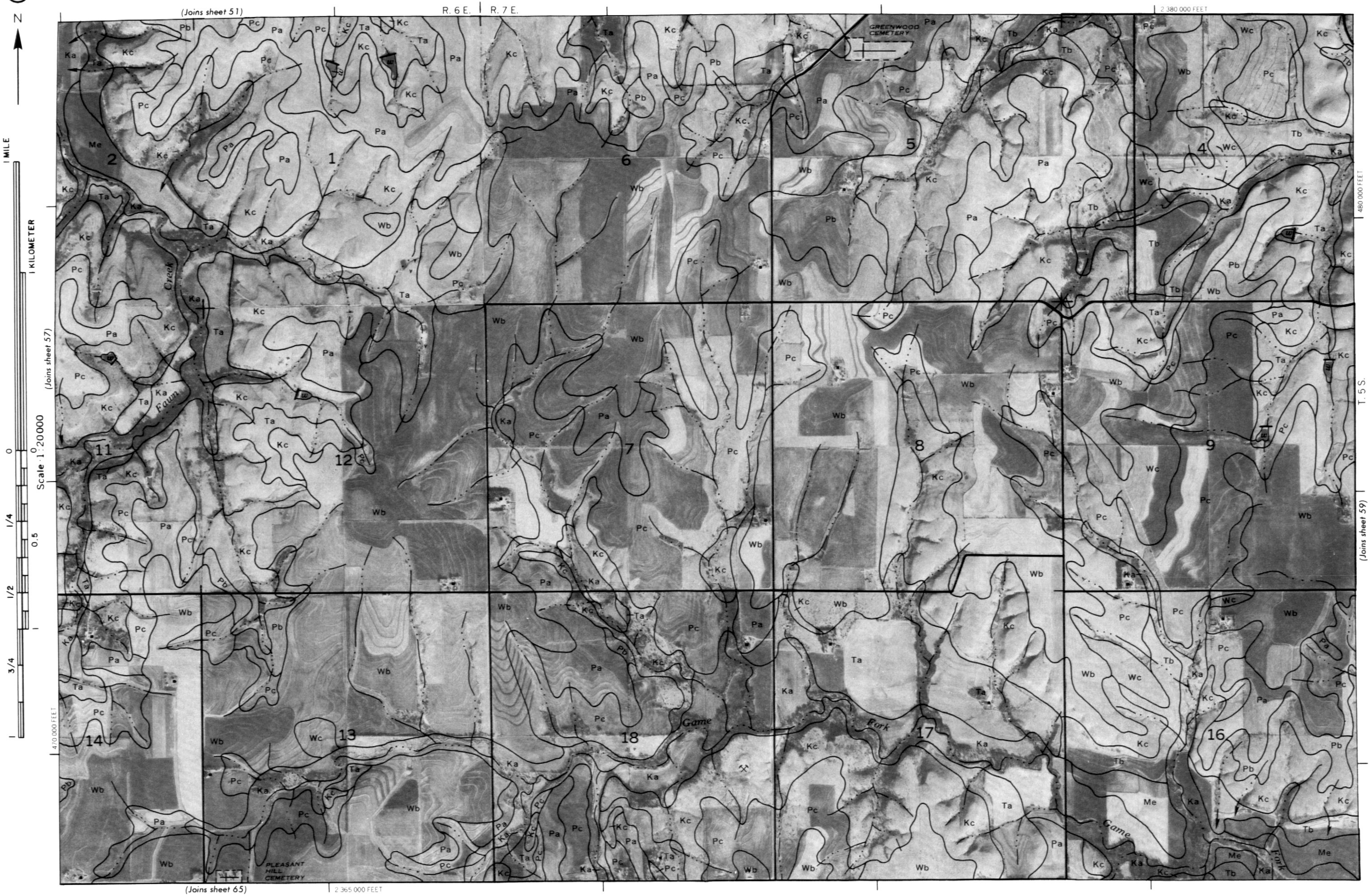

2 455 000 FEET
500 000 FEET
R. 9 E. | R. 10 E.
(Joins sheet 48)
(Joins sheet 56)
(Joins sheet 54)
(Joins sheet 62)
2 475 000 FEET
490 000 FEET
T. 4 S.
N
BLACK VERMILLION RIVER
Irish Creek
UNION PACIFIC
Sullivan
water
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5

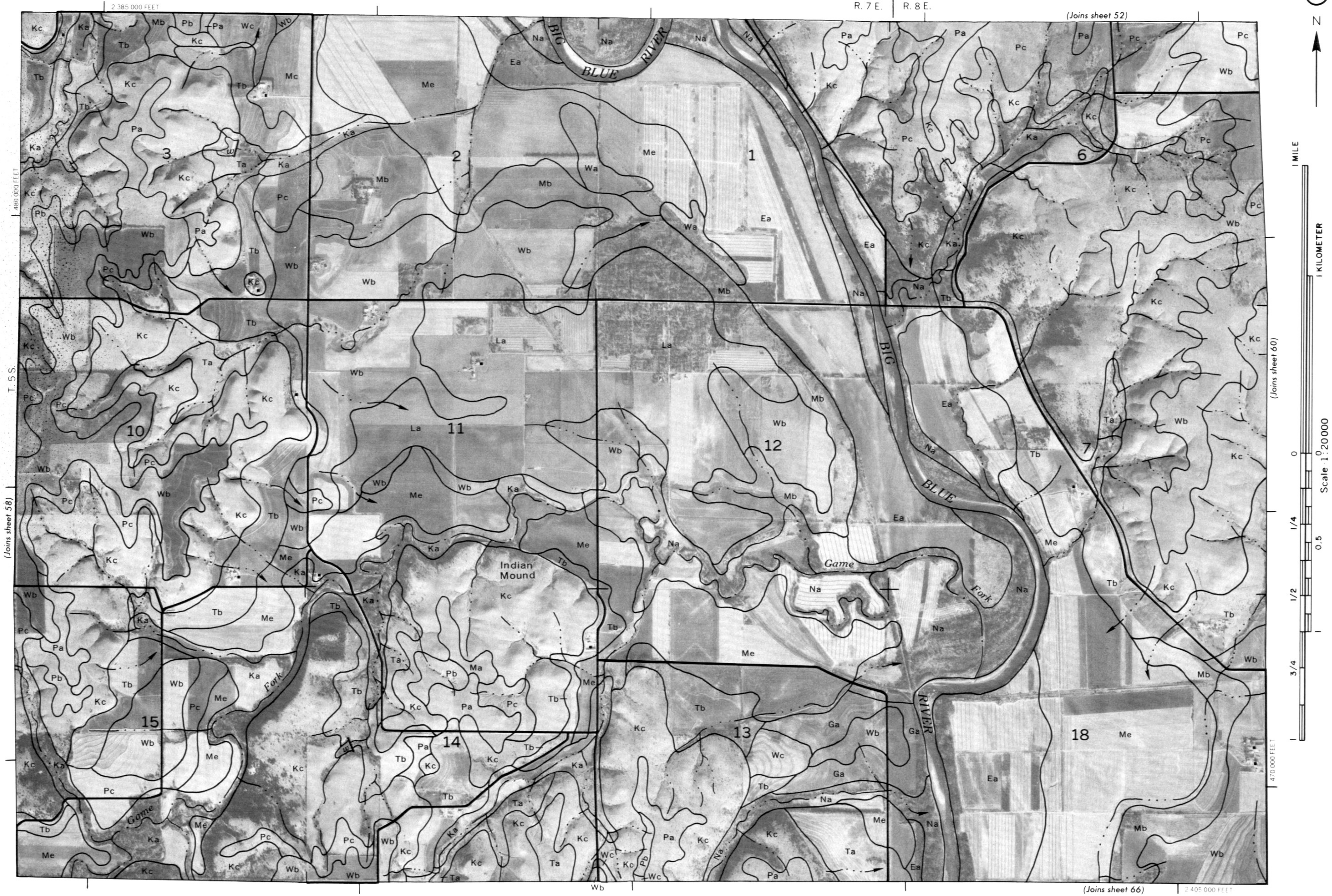
MARSHALL COUNTY, KANSAS — SHEET NUMBER 56



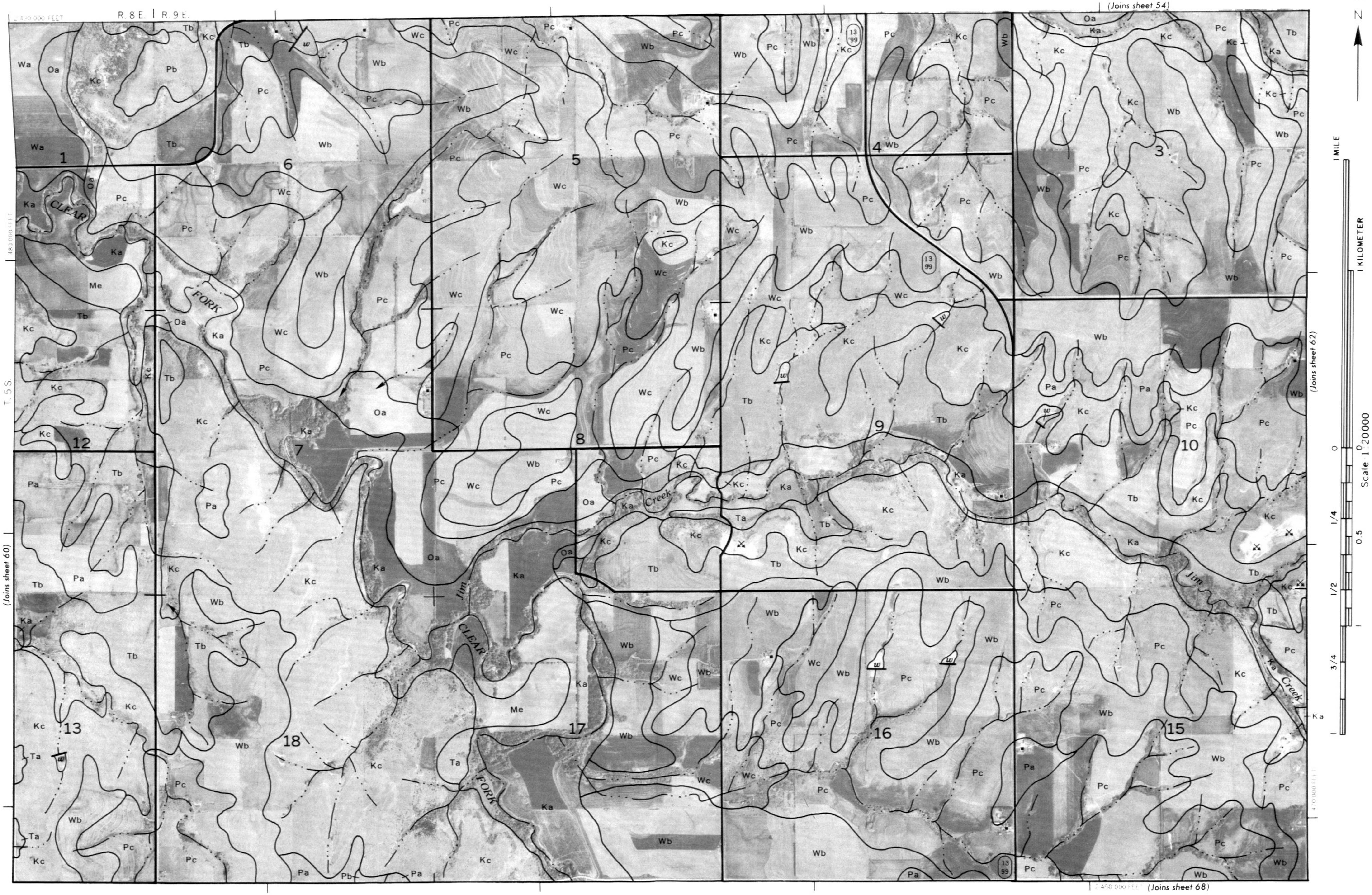


2 340 000 FEET
R. 6 E.
(Joins sheet 50)
480 000 FEET
T. 5 S.
WASHINGTON COUNTY
HARBAUGH CEMETERY
Fawn Creek
Creek
(Joins sheet 58)
470 000 FEET
(Joins sheet 64)
2 360 000 FEET
6
5
4
3
2
7
8
9
10
11
18
17
16
15
14
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1


N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 51)
R. 6 E.
R. 7 E.
2 380 000 FEET
480 000 FEET
T. 5 S.
(Joins sheet 57)
(Joins sheet 59)
470 000 FEET
(Joins sheet 65)
2 365 000 FEET
GREENWOOD CEMETERY
PLEASANT HILL CEMETERY
Fawn Creek
Game Fork
Game Fork

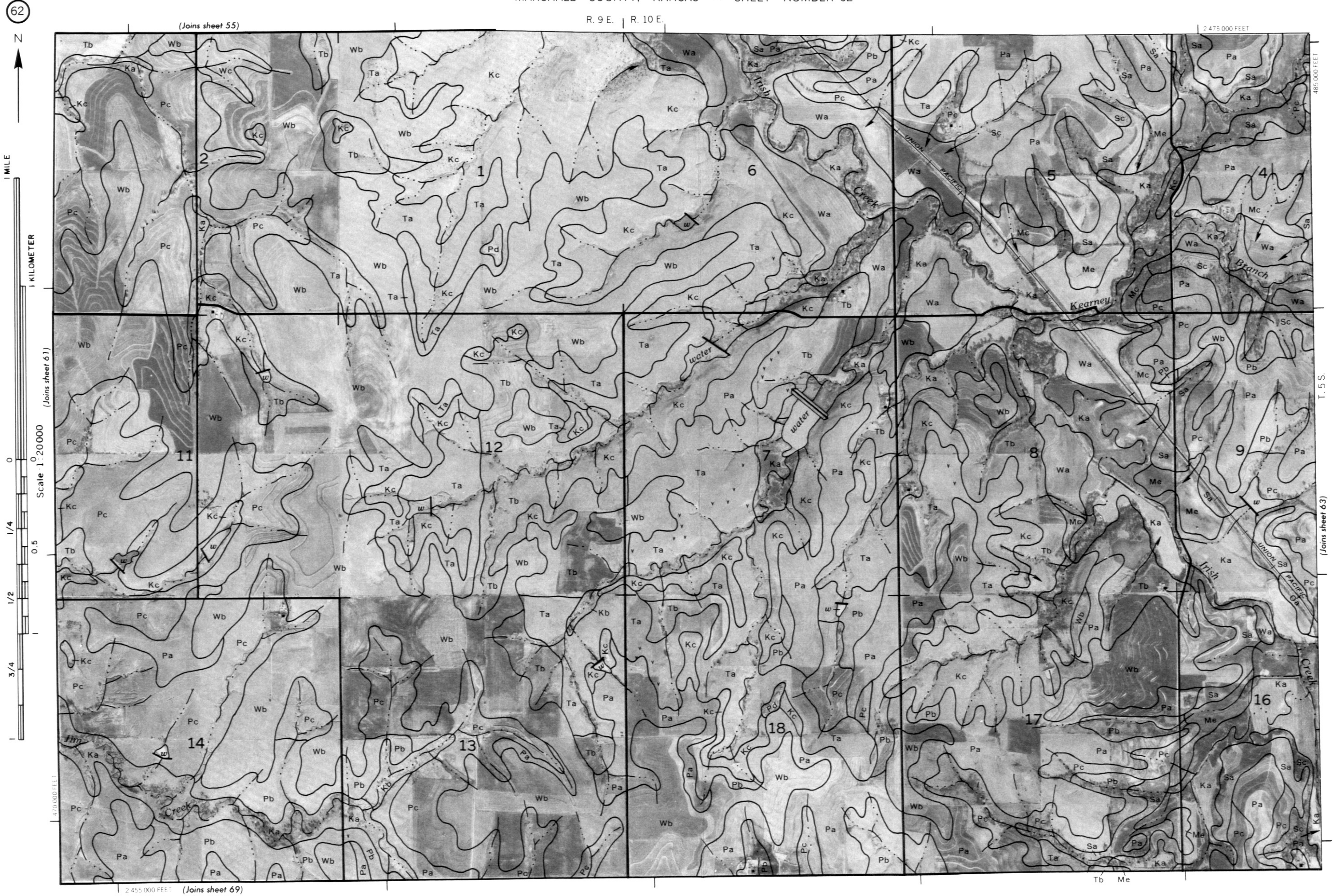

(Joins sheet 52)
(Joins sheet 58)
(Joins sheet 60)
(Joins sheet 66)
R. 7 E.
R. 8 E.
T. 5 S.
BIG BLUE RIVER
Game Fork
Indian Mound
N
1 MILE
1 KILOMETER
Scale 1:20000

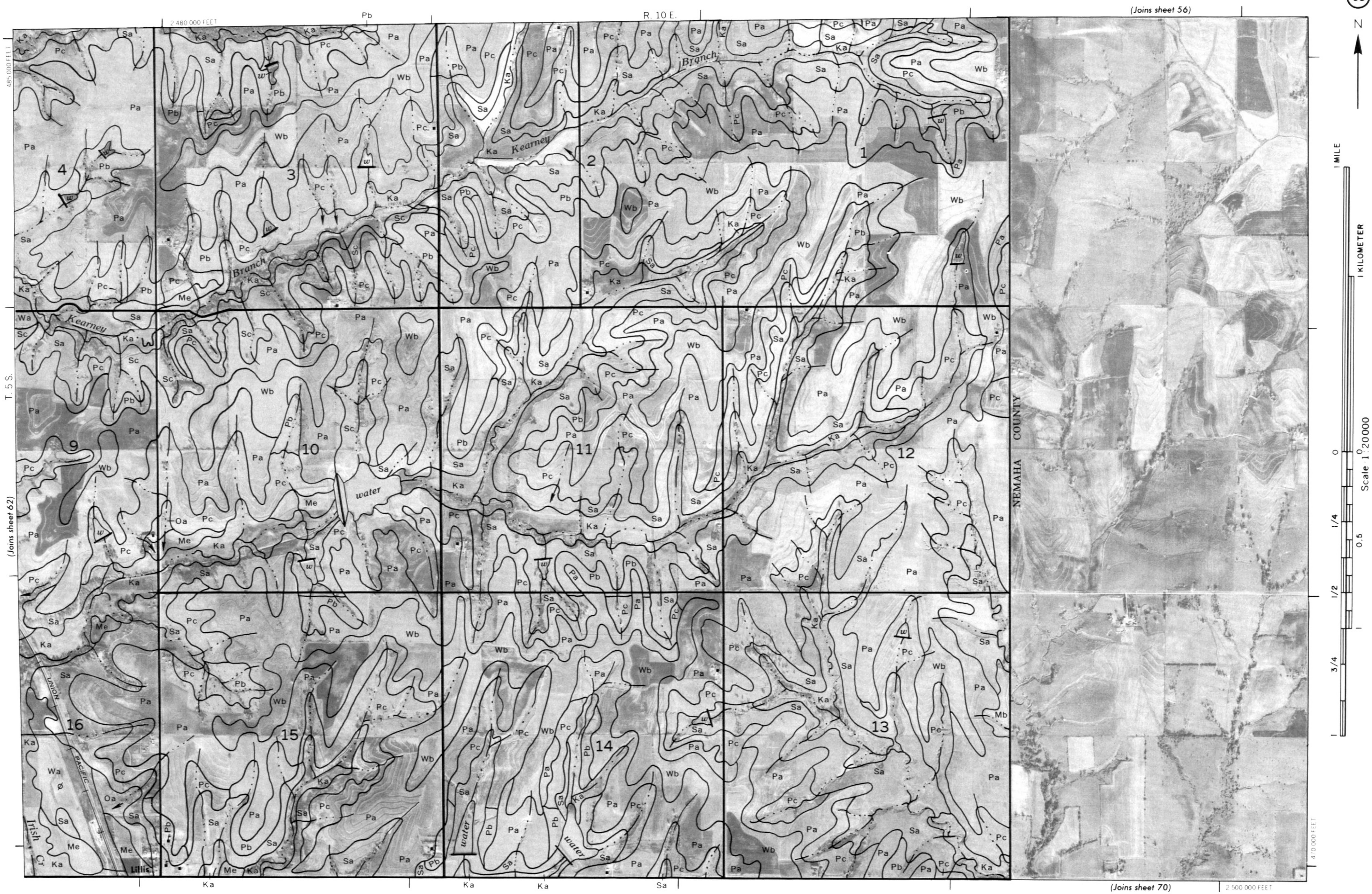

N
1 MILE
1 KILOMETER
Scale 1:20000
(Joins sheet 53)
R. 8 E.
2 430 000 FEET
480 000 FEET
T. 5 S.
(Joins sheet 59)
(Joins sheet 61)
(Joins sheet 67)
2 410 000 FEET
470 000 FEET
Corndodger Cr.
Corndodger
Creek
ANTIOCH CEMETERY
BLACK VERMILLION CLEAR RIVER
FORK
Creek
DeShazer
DeShazer
Creek
RIVER
BLACK VERMILLION
Twin Mounds
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17

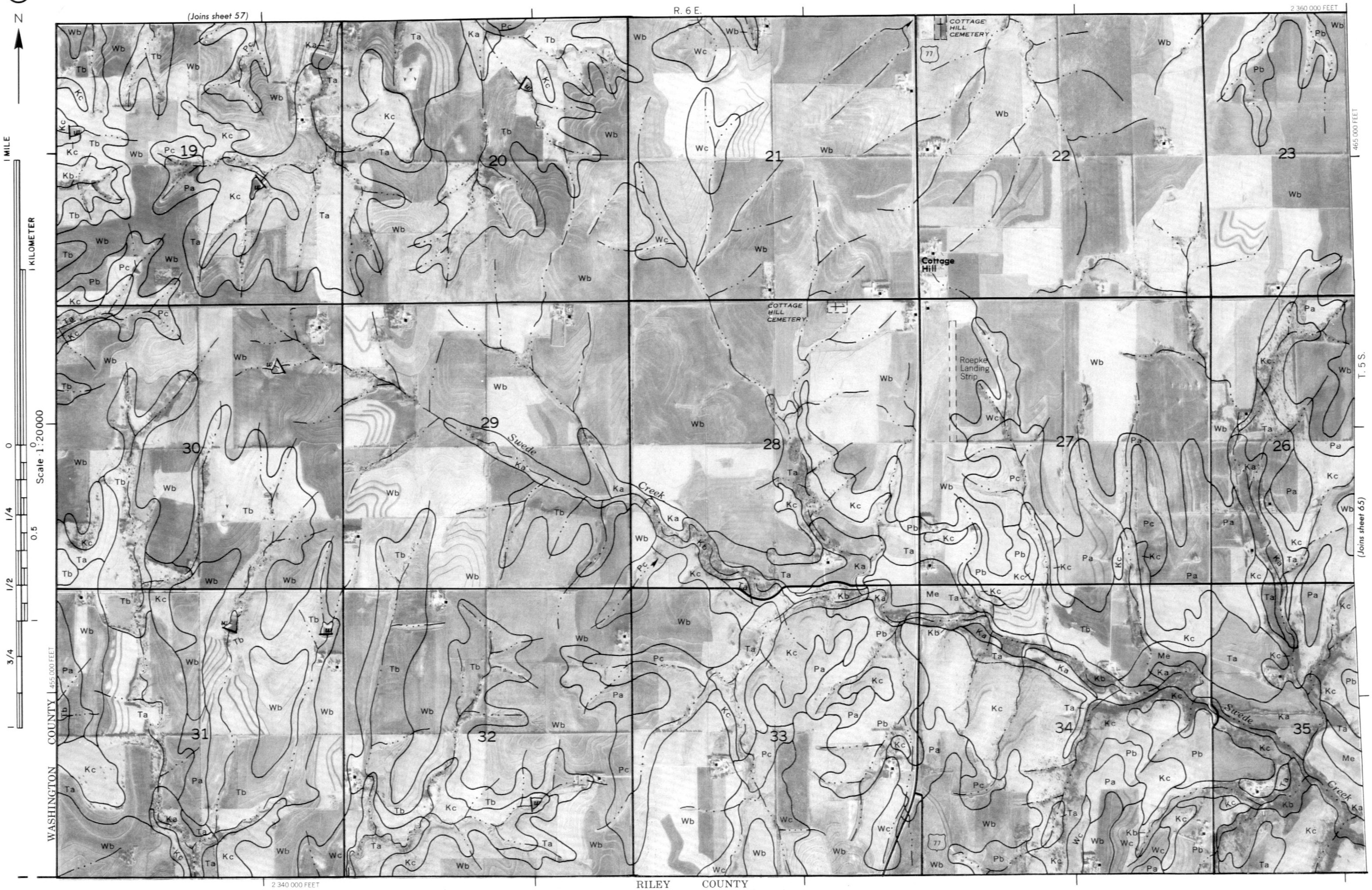


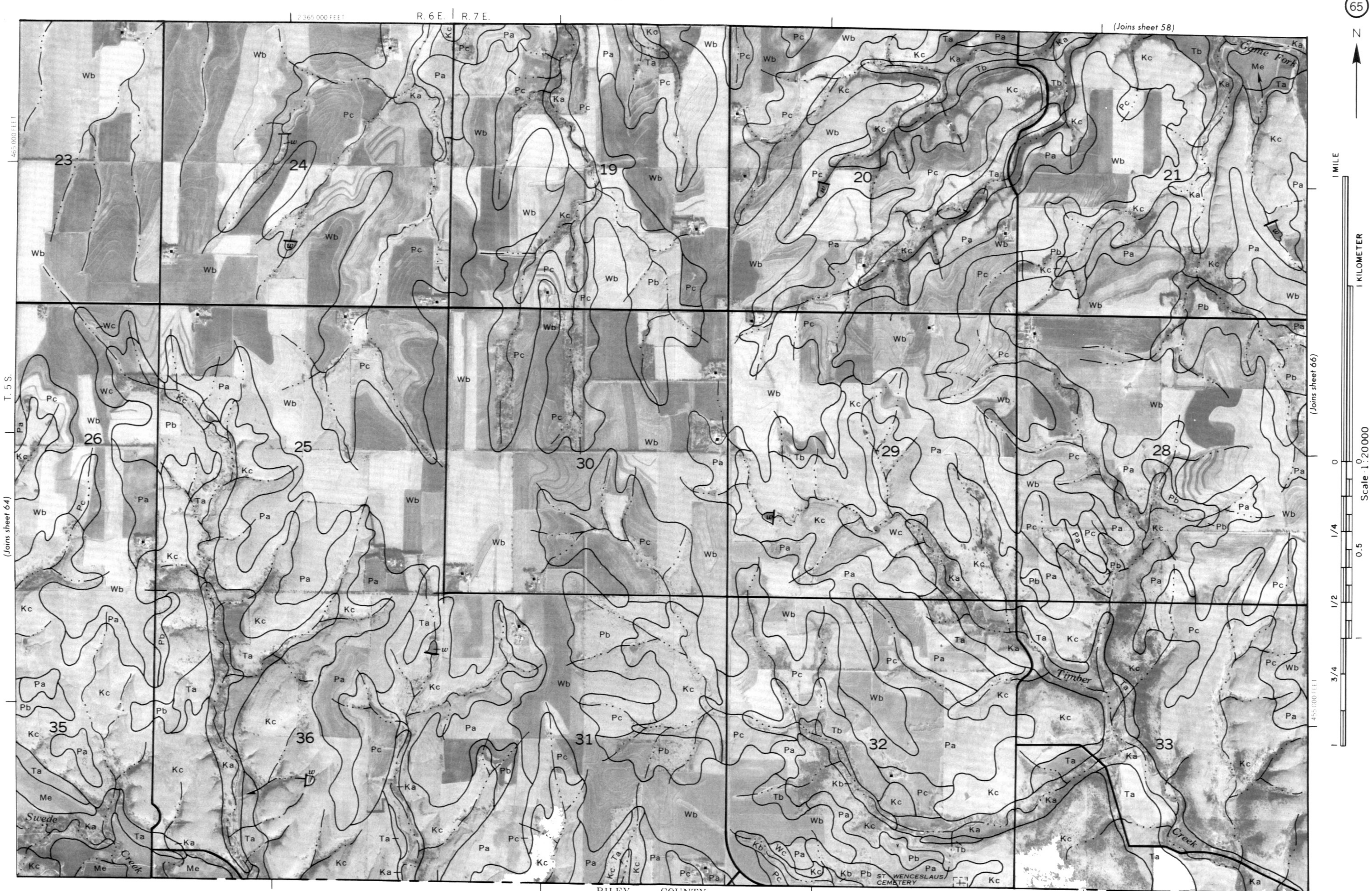
(Joins sheet 54)
(Joins sheet 62)
(Joins sheet 68)
(Joins sheet 60)
R. 8 E. | R. 9 E.
T. 5 S.
2 440 000 FEET
CLEAR
FORK
Jim
Creek
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5

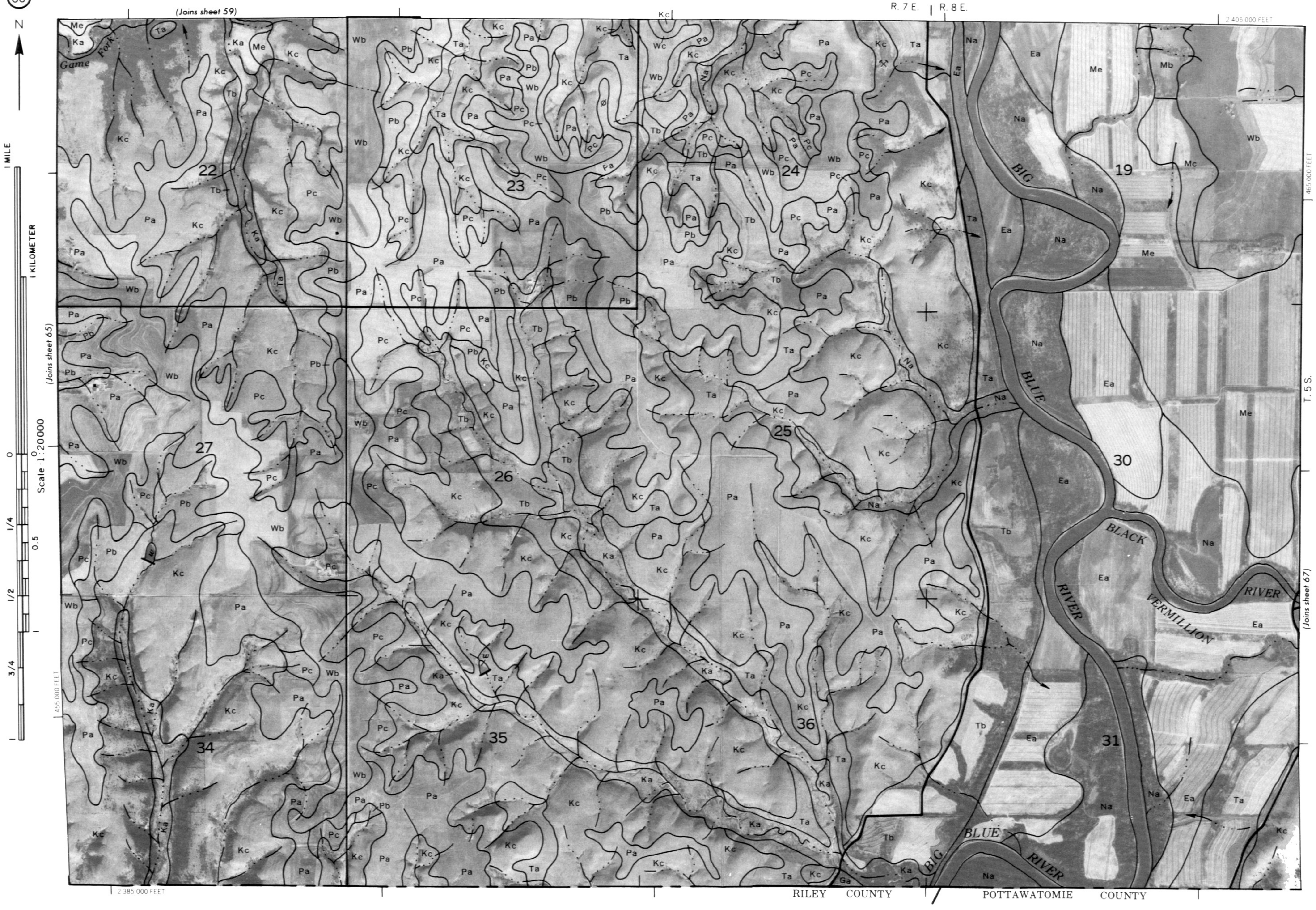
MARSHALL COUNTY, KANSAS — SHEET NUMBER 62

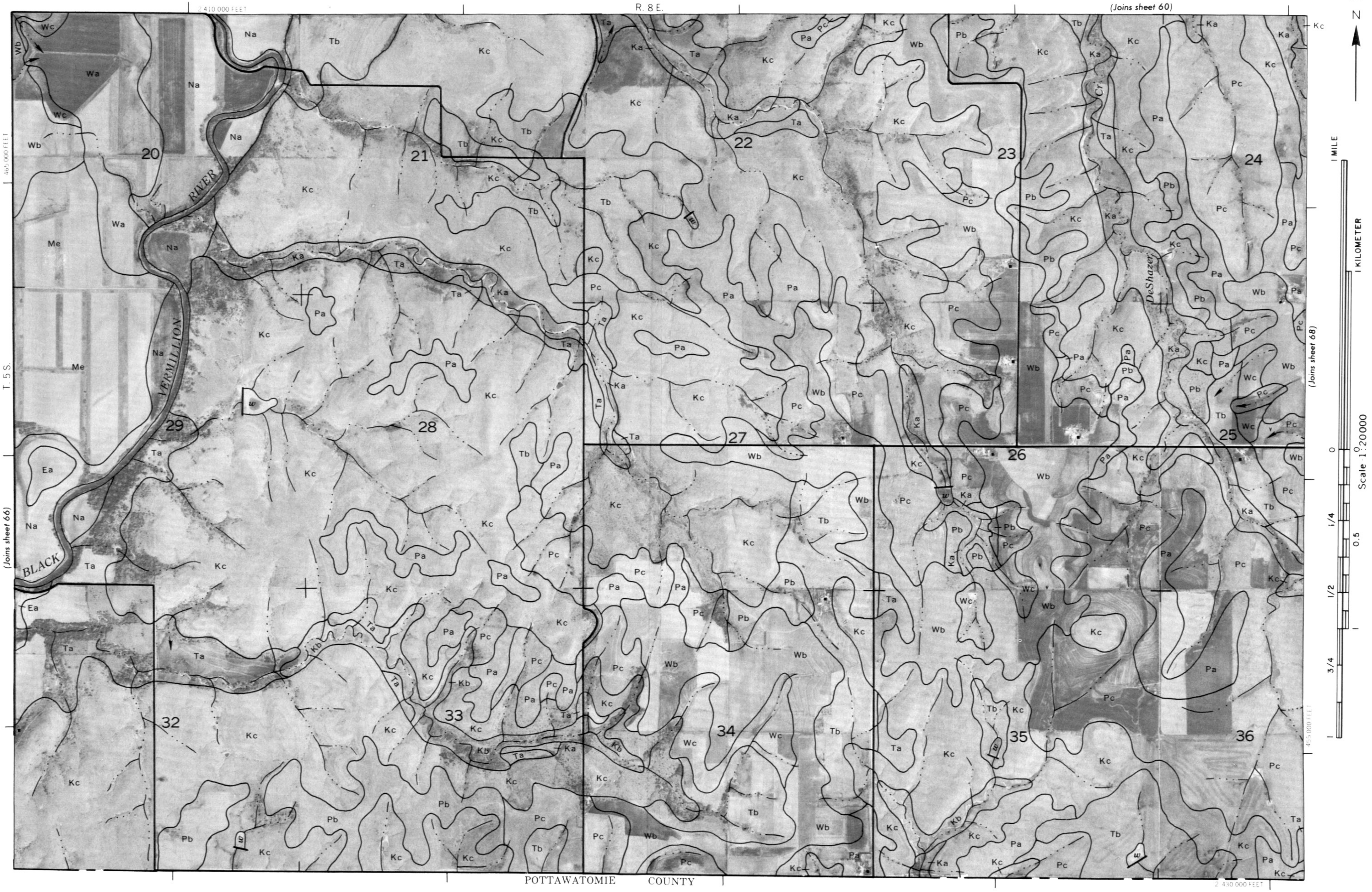



63
(Joins sheet 56)
(Joins sheet 62)
(Joins sheet 70)
R. 10 E.
T. 5 S.
2 480 000 FEET
2 500 000 FEET
485 000 FEET
470 000 FEET
N
NEMAHA COUNTY
Kearney Branch
Irish Cr.
Lillis
UNION PACIFIC
water
1
2
3
4
9
10
11
12
13
14
15
16
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

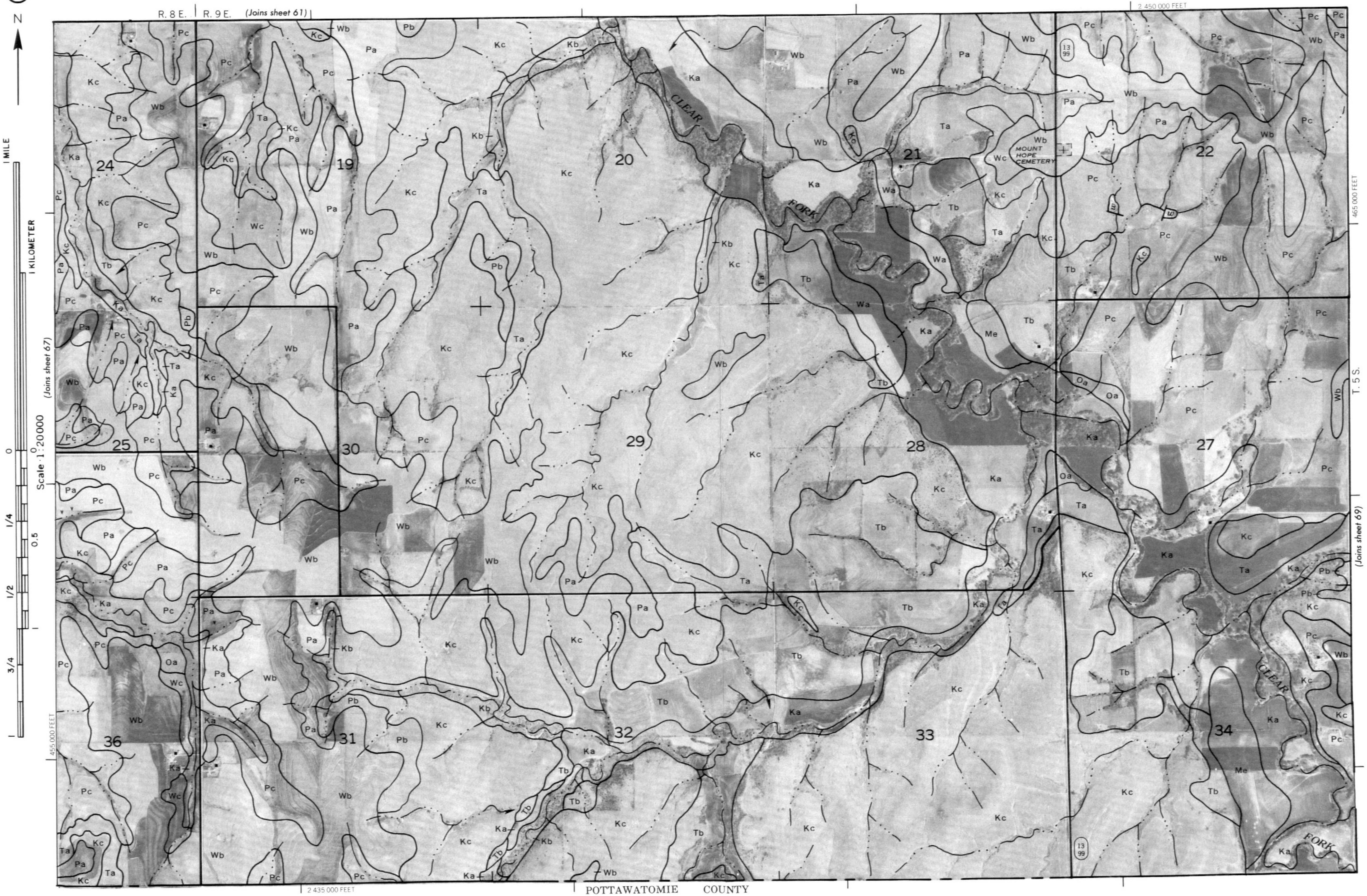

64
N
(Joins sheet 57)
R. 6 E.
2 360 000 FEET
465 000 FEET
T. 5 S.
(Joins sheet 65)
455 000 FEET
2 340 000 FEET
RILEY COUNTY
WASHINGTON COUNTY
1 MILE
1 KILOMETER
Scale 1:20 000
0
1/4
1/2
3/4
0.5
COTTAGE HILL CEMETERY
Cottage Hill
Roepke Landing Strip
Swede Creek
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35

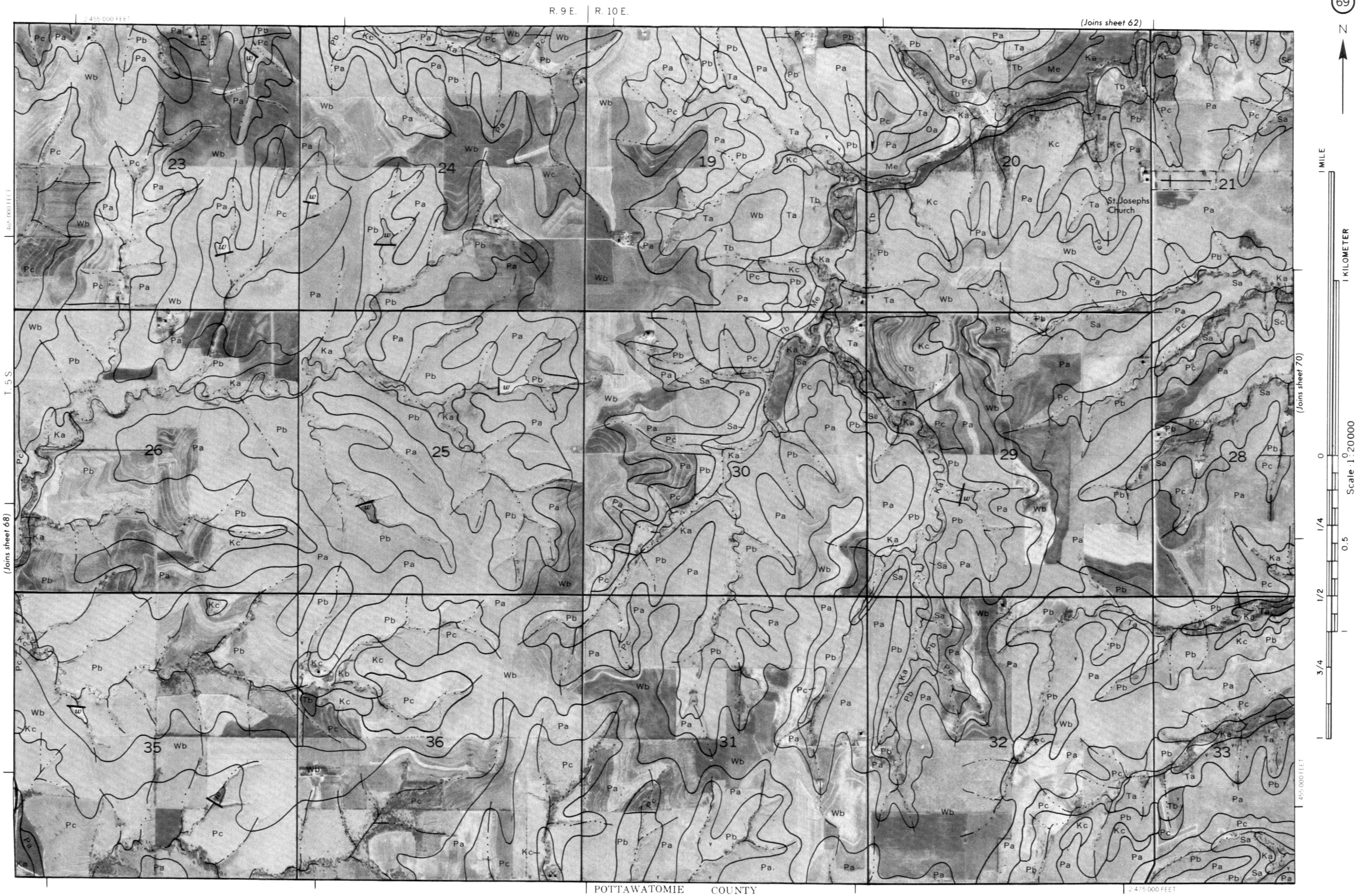

65
N
R. 6 E.
R. 7 E.
2 365 000 FEET
(Joins sheet 58)
(Joins sheet 64)
(Joins sheet 66)
T. 5 S.
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33
Game Fork
Swede Creek
Timber Creek
ST. WENCESLAUS CEMETERY
RILEY COUNTY
2 380 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000

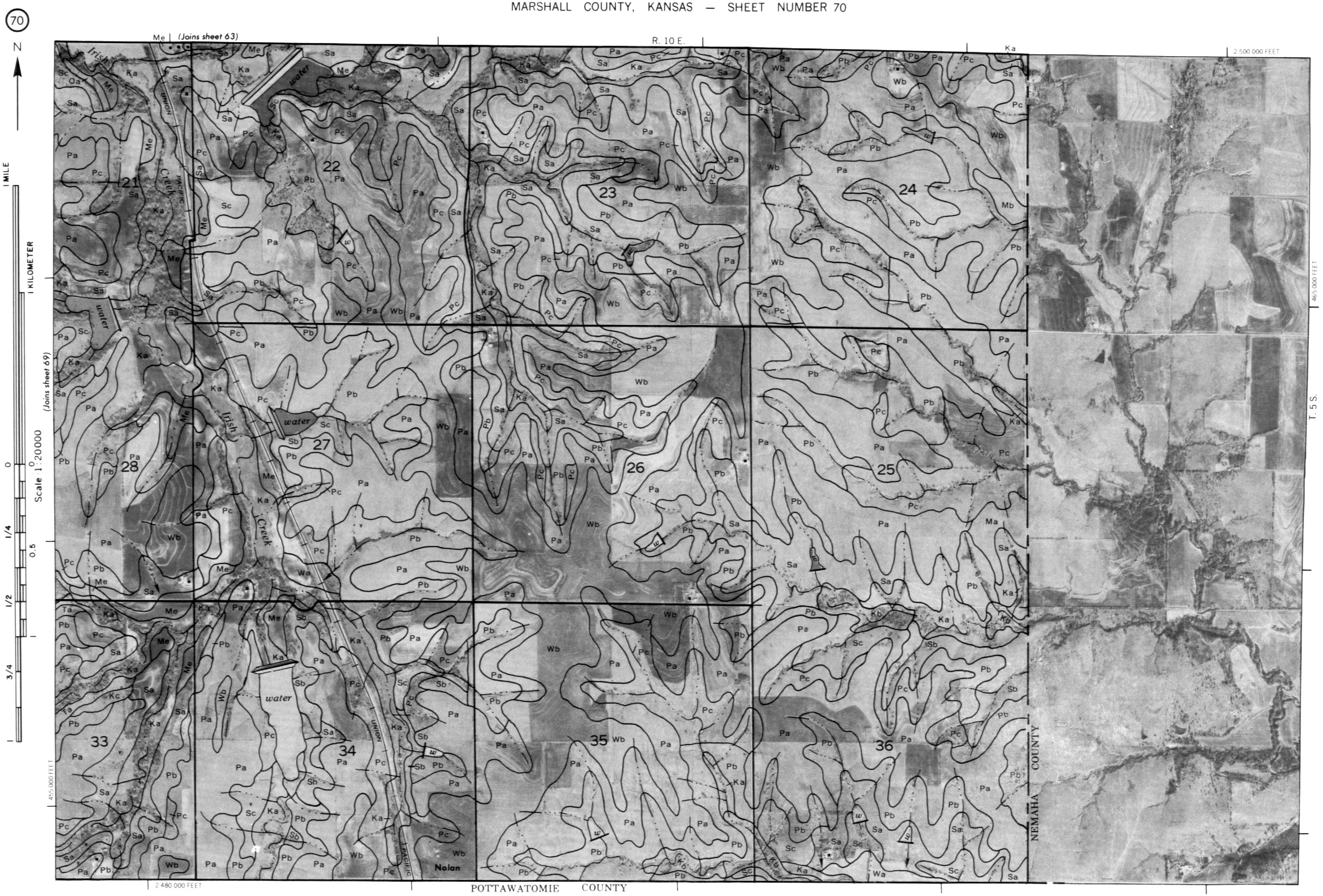

(Joins sheet 59)
(Joins sheet 65)
(Joins sheet 67)
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
R. 7 E.
R. 8 E.
T. 5 S.
2 405 000 FEET
465 000 FEET
455 000 FEET
2 385 000 FEET
Game Fork
BIG BLUE RIVER
BLACK VERMILLION RIVER
BIG BLUE RIVER
22
23
24
19
27
26
25
30
34
35
36
31
RILEY COUNTY
POTTAWATOMIE COUNTY


67
R. 8 E.
(Joins sheet 60)
(Joins sheet 66)
(Joins sheet 68)
T. 5 S.
N
1 MILE
1 KILOMETER
Scale 1:20000
VERMILION
RIVER
BLACK
DeShazer
POTTAWATOMIE COUNTY
2 410 000 FEET
2 430 000 FEET
465 000 FEET
455 000 FEET
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36

MARSHALL COUNTY, KANSAS — SHEET NUMBER 68




69
R. 9 E.
R. 10 E.
(Joins sheet 62)
(Joins sheet 68)
(Joins sheet 70)
T. 5 S.
2 455 000 FEET
2 475 000 FEET
N
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33
St. Josephs Church
POTTAWATOMIE COUNTY
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5


70
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
(Joins sheet 63)
(Joins sheet 69)
R. 10 E.
T. 5 S.
2 500 000 FEET
465 000 FEET
455 000 FEET
2 480 000 FEET
UNION PACIFIC
Irish Creek
water
Nolan
21
22
23
24
25
26
27
28
33
34
35
36
NEMAHA COUNTY
POTTAWATOMIE COUNTY